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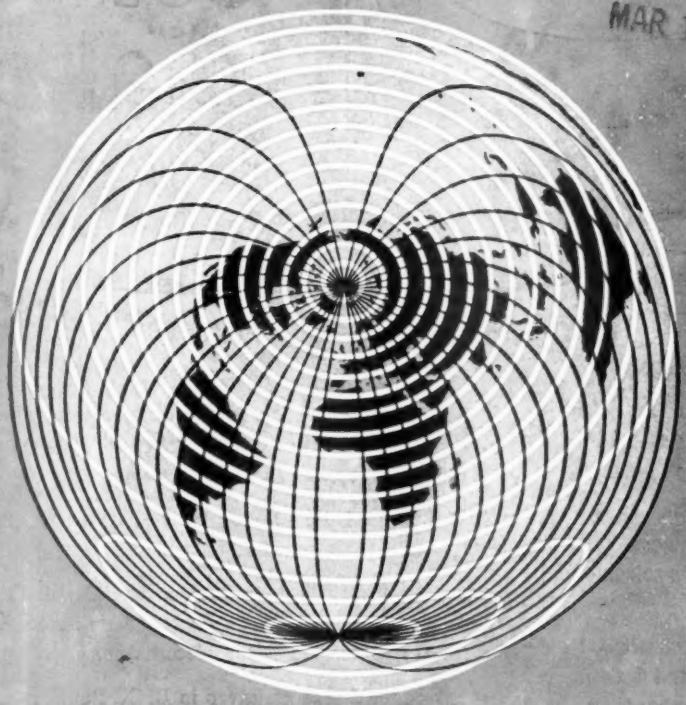

FORTY-SEVENTH YEAR OF PUBLICATION

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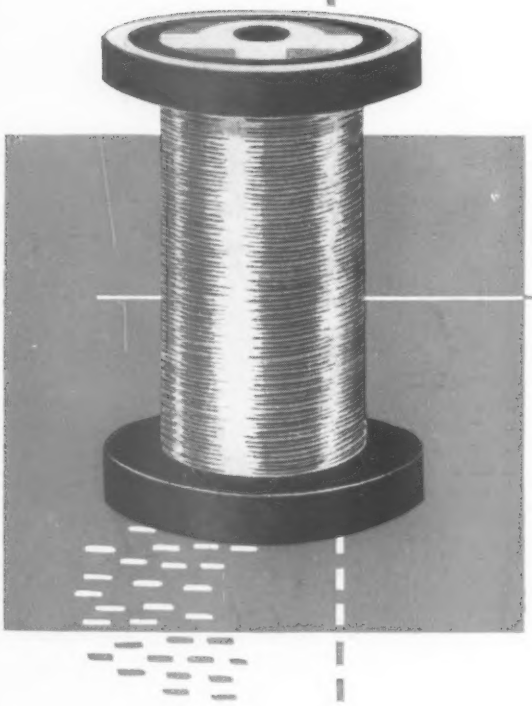

news for coil makers

a TOUGH self-fluxing winding wire

For continuous operation at "hottest-spot" temperatures of up to 120°C.

Adherent and resistant to solvents.

Can generally be used without changes in coil design, winding or impregnation.

Developed in BICC's own laboratories, Bicelflux is an enamel covering for winding wires with toughness approaching that of vinyl acetal or epoxy resin coverings but—*much easier to solder*.

Bicelflux is self-fluxing, with an action comparable to that of organic activated rosin fluxes.

As a result, Bicelflux windings are ideal for applications where large numbers of soldered joints are required, for example in radio and telecommunication equipment.

Further details are given in BICC Publication No. 376 —yours for the asking.

BICC Bicelflux **WINDING WIRES**

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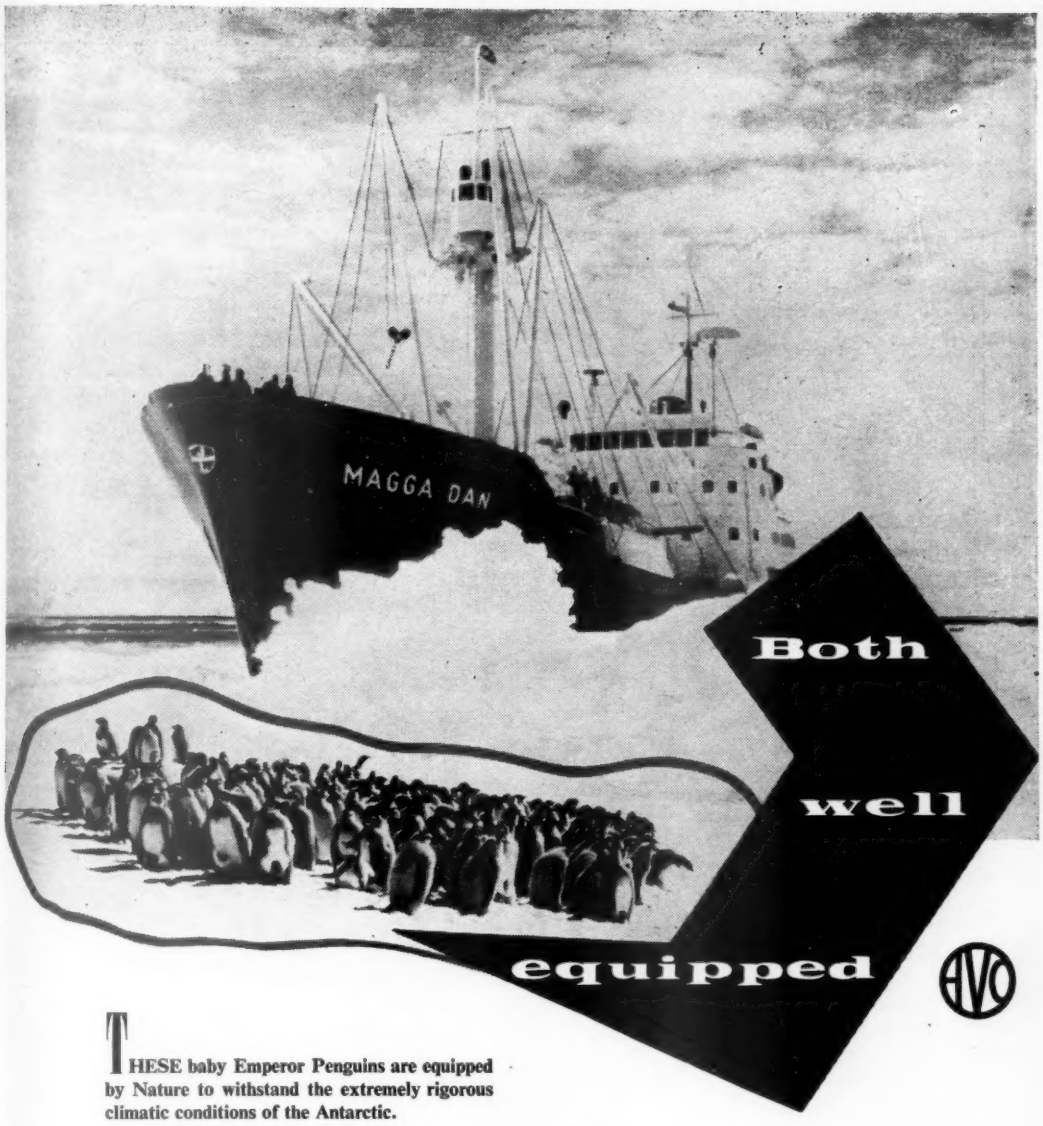

THESE baby Emperor Penguins are equipped by Nature to withstand the extremely rigorous climatic conditions of the Antarctic.

The Trans-Antarctic and Royal Society Expeditions are also adequately and admirably equipped with the most advanced scientific apparatus to carry out their highly important research work.

The electrical and radio communications equipment inevitably requires constant checking and maintenance. AVO are gratified that their instruments were amongst those chosen for this vital work.

Among the AVO instruments with these Expeditions are the famous Model 7 and 8 AvoMeters, Universal Avominors, the AVO Valve Tester Type 160, a modified AM/FM Signal Generator Type T.F.M., and AVO Exposure Meters.

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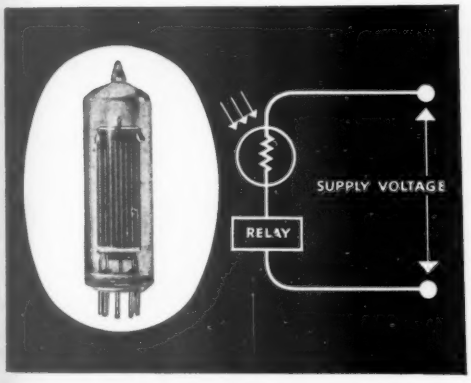

New cadmium sulphide technique revolutionizes photocell performance

A new type of photocell with an entirely new order of performance has been developed in the Mullard Solid State Physics Laboratories and is now about to go into production.

Employing a large area cadmium sulphide photosensitive element, the new cell provides a sensitivity approaching that of a photomultiplier . . . *and* a current handling capacity of tens of milliamps.

Technical information is in the course of preparation and you are invited to write to the address below.

Robust relays operated without amplifiers

At the extremely low illumination of 5 ft. candles, robust relays can be operated direct from 40 volt supplies.

Low dark current

In typical applications the ratio of light to dark current is in general more than 10,000 : 1.

Wide spectral response

The usable response extends through the entire visible spectrum to the near infra-red and peaks in the yellow/red region.

A.C. or D.C. operation

The cadmium sulphide type of photocell is non-polar and can be used with either a.c. or d.c. supplies.

Sturdy construction

Like many other solid state devices, the new type of cell is inherently rugged and suited for industrial use.

Wide range of applications

Flame failure detection, door opening, street lighting control, conveyor control, illumination control and smoke monitoring are only a few of the many possible applications.

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MVT 344b

Mozart Lowboy

The revolutionary small amplifier in a specially designed cabinet . . .

The brilliant new Pye Mozart is one of the smallest and most compact amplifiers ever devised for home use. It gives an undistorted output of 10 watts, provides full controls and facilities for reproduction from all high fidelity sources, yet the chassis measures only 10½" x 3½" x 5". The Mozart's exacting specification has been reached only through good design and hand-finishing by carefully selected craftsmen who are expert at complex wiring and assembly. Its low price is the direct result of the leadership of Pye in printed circuit production.

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Pye Corporation of America, 1149 Raritan Avenue, Highland Park, New Jersey, U.S.A.

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Pye Radio and Television (Pty.) Ltd., Johannesburg, South Africa.

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MOZART LOWBOY

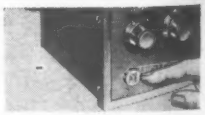
This new Pye model features the Mozart Amplifier mounted in an elegant cabinet finished in walnut veneers and provides space for the fitting of any type of transcription turntable.

DIALOMATIC SELECTOR

The Mozart has input facilities for records, tape and radio. New 'dialomatic' pick-up compensation unit gives instant matching for most types of pick-up.

ON/OFF PUSH BUTTON

This is completely separate from the volume control and eliminates all mains interference.



SIMPLIFIED CIRCUITRY

This brilliantly simplified printed circuit uses only 3 valves, a metal rectifier and a minimum of capacitors and resistors, allowing a great saving of space.

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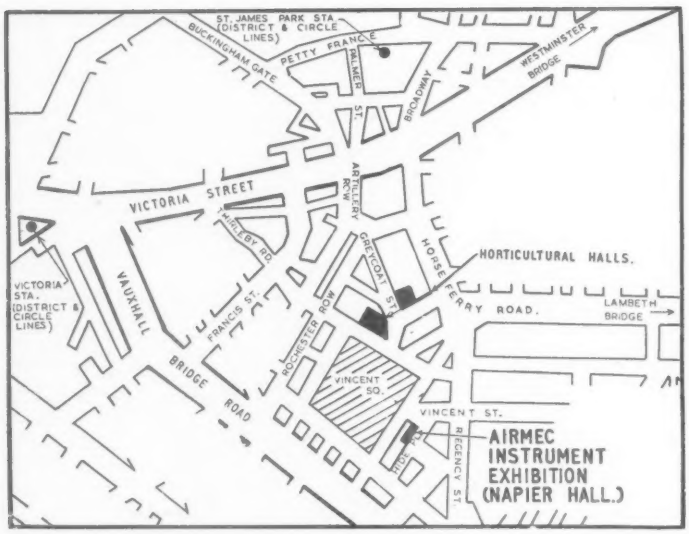

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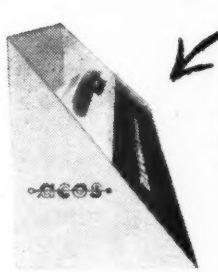


The Black Shadow makes its appearance in a fancy black and yellow transparent box You'll find it at your dealer's

THE BLACK SHADOW

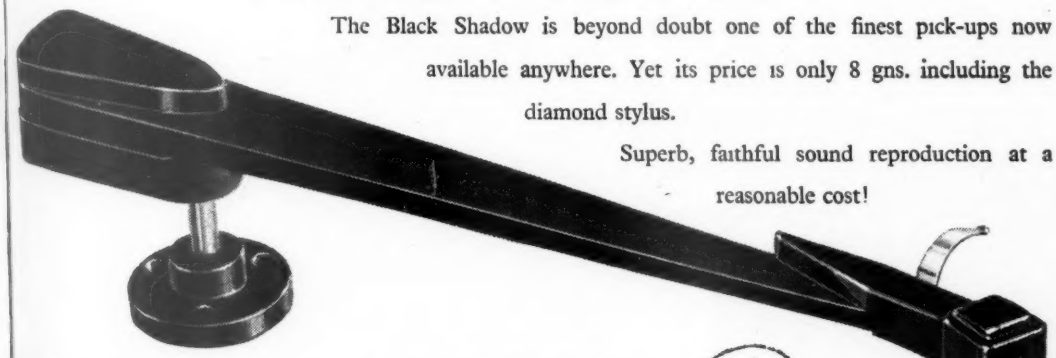
The Black Shadow, the new pick-up arm from Acos, is a dramatic advance.

With its associated network, The Black Shadow achieves a level response up to approximately 18 kc/s (within ± 3dB) without any further correction. It feeds directly into practically every high-quality amplifier.

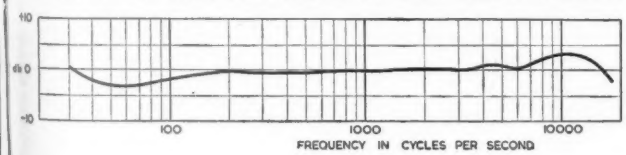
An alternative output, from a selector switch, gives a velocity characteristic to feed directly into the magnetic pick-up input of an amplifier

The Black Shadow is beyond doubt one of the finest pick-ups now available anywhere. Yet its price is only 8 gns. including the diamond stylus.

Superb, faithful sound reproduction at a reasonable cost!



The Level characteristics of The Black Shadow



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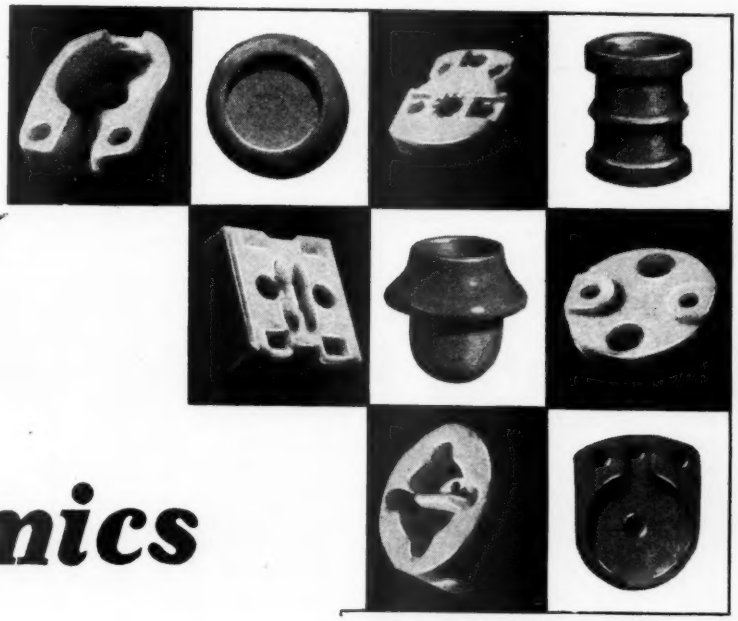

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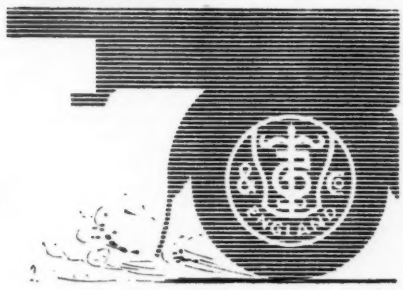

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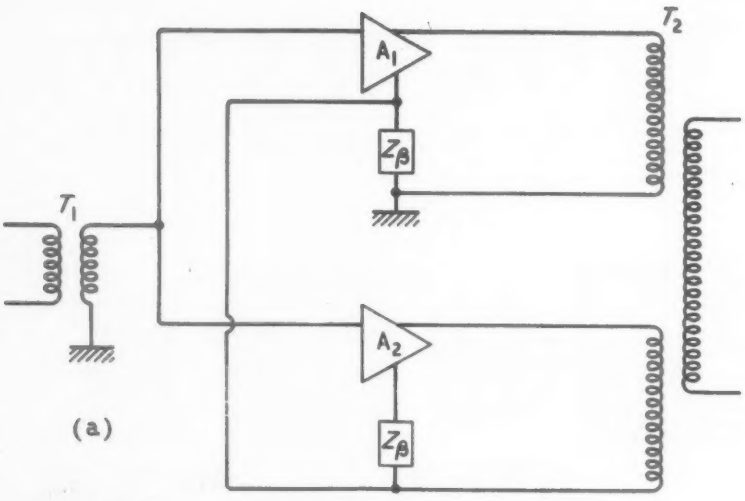

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A new principle, described in the February issue of ELECTRONIC & RADIO ENGINEER, enables the amount of negative feedback applied to an amplifier to be increased from A dB to $2A$ dB without affecting the margin of stability. The difference between the input and the fed-back signals is applied to another amplifier, the output of which is combined with that of the first. An additional advantage of the system is that if either amplifier becomes inoperative, the other continues to function with almost the same gain and with A dB feedback.

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A combination of lumped capacitance and transmission-line elements provides filters suitable for the v.h.f. range. The effect of multiple pass-bands can be eliminated by stagger-tuning two filters.

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An improved limiter embodying a single diode and a harmonic-rejection circuit is considered theoretically in conjunction with a variety of Foster-Seeley discriminator. Non-linear distortion of less than 0.1% for any harmonic can easily be obtained.

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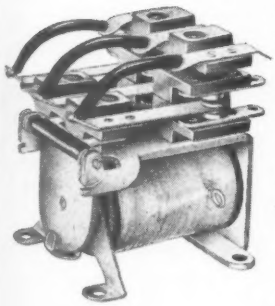
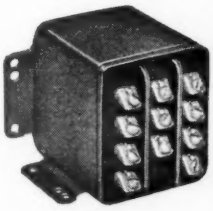


These relays of simple and robust construction are designed to work under adverse conditions. The use of such features as high contact pressures and generous wiping action enable them to comply with the Service requirements of DES.1 and DEF.5000.

Both sealed and open types are available with up to 4 pole changeover contacts. The standard relays operate on 28 volts D.C. and enquiries for other operating voltages are welcome. Hermetic enclosure of the sealed types ensures complete freedom from the effects of humidity, altitude and tropical exposure. Also the case protects the relay from mechanical damage and operator interference.



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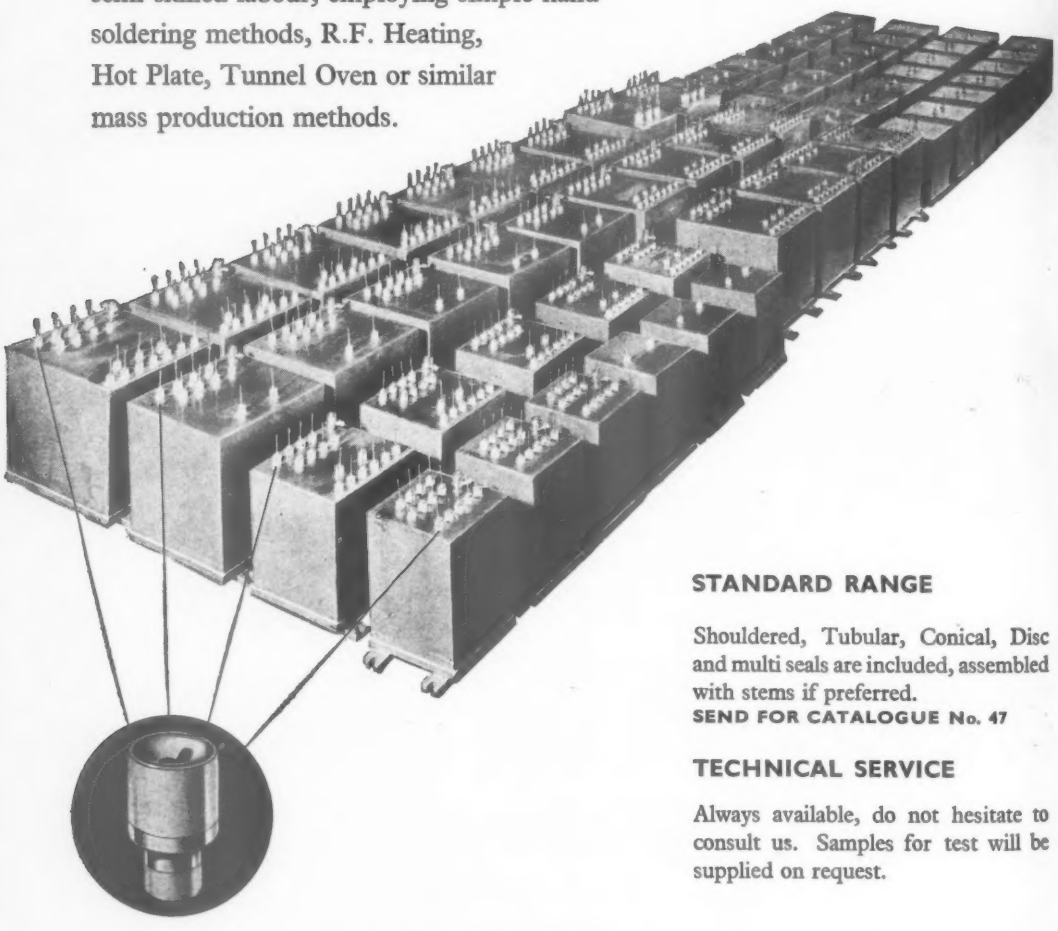

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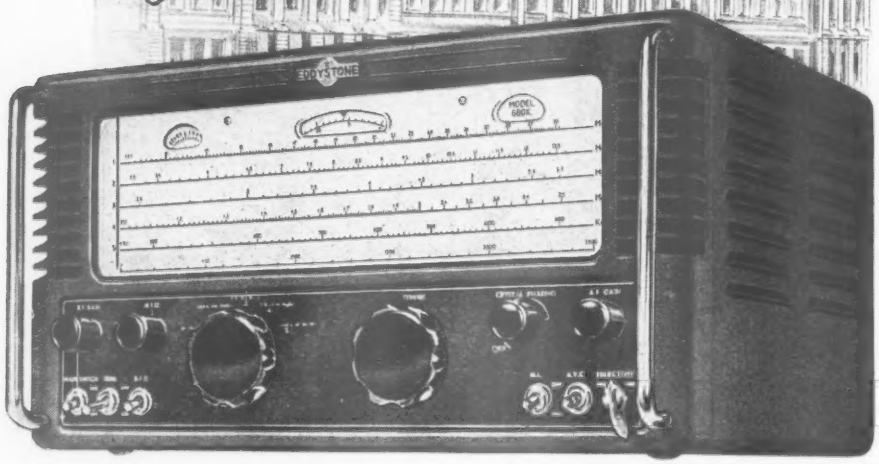
for the Professional User



The controls of the Eddystone "680X" receiver are laid out so conveniently that the Professional operator quickly "takes" to the receiver and is able to make the most of its extremely good performance. All normal communications facilities are provided :— variable pitch BFO; crystal filter; wide range of selectivity; noise limiter; 600 ohm balanced output. There are two RF and two IF stages, all valves being of Service-approved types. Frequency coverage is continuous from 480 kc/s to 30 Mc/s. Available in table and rack-mounting versions. Robust all-metal construction and suitable for use in any climate. The illustrated brochure gives full particulars and you are cordially invited to write for it.

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MODEL 680X

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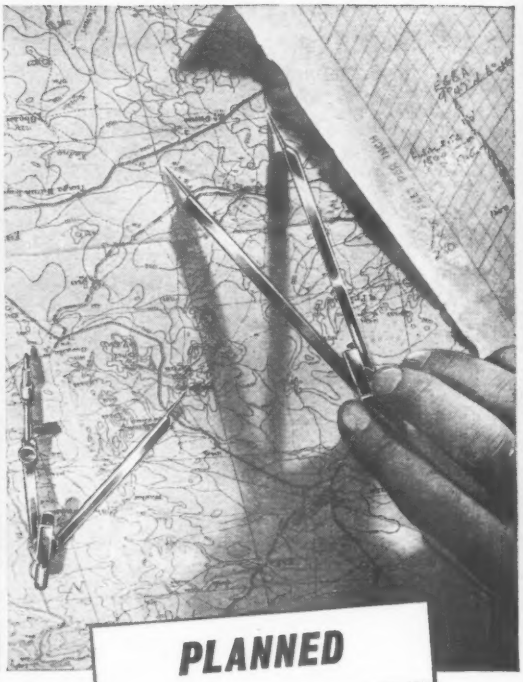

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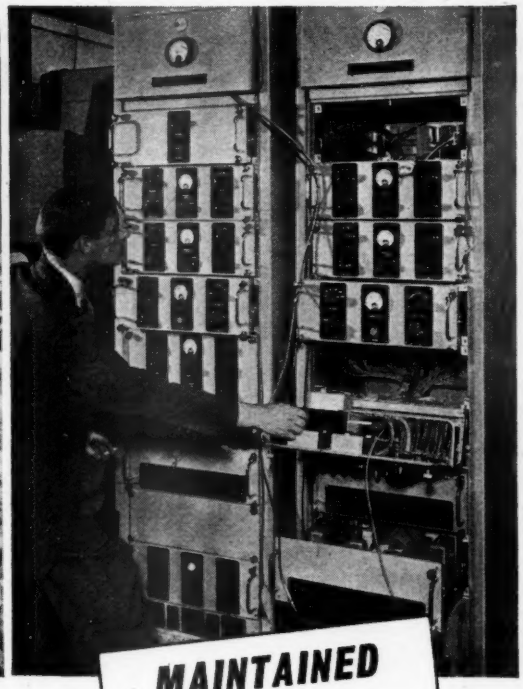

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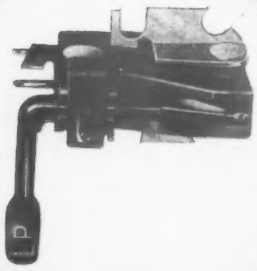
INTRODUCING THE SONOTONE 2T



All the recorded sound — that's the way the 'Sonotone' 2T equipped radiogramophone will play it! The revolutionary Sonotone pick-up head — a superior, highly sensitive product — represents another step forward in modern sound head technique by T.C.L. It is completely humidity and temperature proof, produces no magnetic hum and has a great many other technical advantages which are discussed fully in T.C.L. publication No. 1106. Design Engineers are invited to ask for a copy and for any further technical information they may require.

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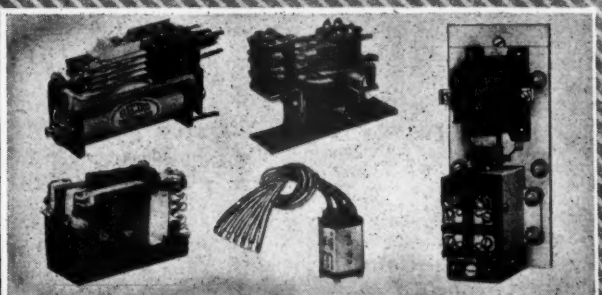

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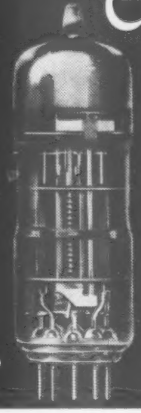
a new valve for 470 Mc/s equipment



QQVO2-6

– unique double tetrode range extended

Here is a new six watt double tetrode for low cost 470Mc/s mobile equipment. This compact valve features a frame grid and the same unique twin construction as other Mullard double tetrodes—a construction which provides high efficiencies, high power gain and heater economy.

Other features of the QQVO2-6 include built-in neutralising capacitors which enable circuitry to be simplified, and low inter-electrode capacitances which allow wide tuning ranges to be achieved and which contribute to high efficiency.

Write to the address below for full details of the QQVO2-6 and other Mullard double tetrodes.

BASE B9A
CATHODE ... ... Indirectly heated
HEATER (Centre tapped)
Series 12.6V, 0.3A
Parallel 6.3V, 0.6A

CAPACITANCES

*ca–g′ (each section)	less than 0.16pF
cg′–all (each section)	6.4 pF
ca–all (each section)	1.6 pF
cout (two sections in push-pull)	0.95 pF
cin (two sections in push-pull)	3.8 pF

* Internally neutralised for push-pull operation.

CHARACTERISTICS
(each section) measured at Ia = 25mA, Va = Vg″ = 150V.

gm	10.5mA/V
μg′–g″	31

TYPICAL OPERATING CONDITIONS

	Telegraphy or F.M.	Telephony—A.M.	
f	470	470	Mc/s
Va	180	180	V
Vg2	180	180	V
Ia	2 x 27.5	2 x 20	mA
pa	2 x 2.1	2 x 1.5	W
Pout	5.8	4.2	W
Pload	4.5	3.4	W

THE MULLARD DOUBLE TETRODE RANGE
. . . . the most comprehensive and efficient in the world

	Typical F.M., Power Output
QQVO2–6	5.8 watts
QQVO3–10/6360 (CV2798)	11 watts
QQVO3–20A/6252 (CV2799)	25 watts
QQVO6–40A/5894 (CV2797)	56 watts

Mullard
COMMUNICATIONS AND INDUSTRIAL VALVE DEPARTMENT

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TORRINGTON PLACE · W.C.1 · Tel: LANgham 6633
MVT. 343a

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Square, rectangular and slotting tools.

In addition to the range of Punches and Dies $\frac{1}{8}$" to $3\frac{3}{4}$" dia. available from stock, some of the tools usually required in the Radio and Electronic Industry have been standardised for use with the Hunton Universal Bolster Outfit. Illustrated above are a few which can be supplied quickly or from stock. In London and Home Counties, ask for a practical demonstration in your own works. Alternatively, write for illustrated price list W.W.1.

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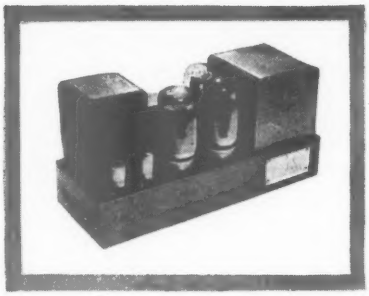
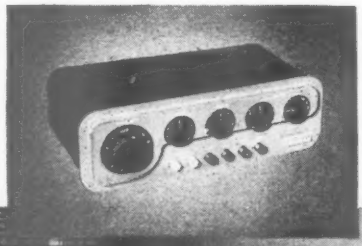
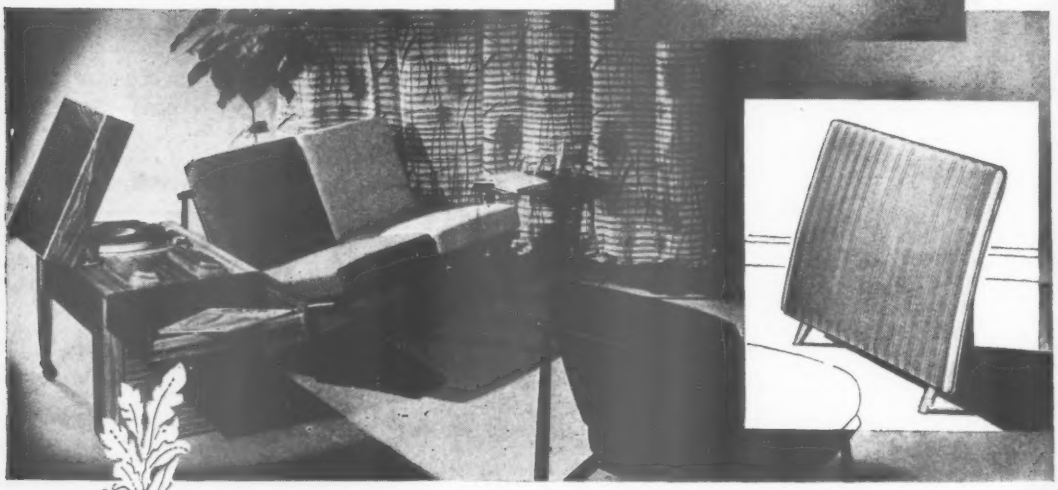
For the closest approach to the Original Sound— that your enjoyment and appreciation of music may be unimpeded







Please ask for illustrated literature describing the QUAD II Amplifier, FM Tuner and Electrostatic Loudspeaker.

ACOUSTICAL MANUFACTURING CO. LTD.
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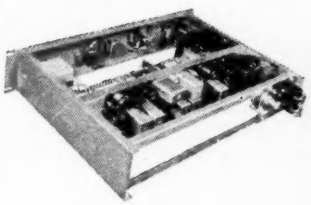
Communications Equipment

TWO

examples from a wide range

Electronic Muting Unit PV97A For High Frequency Receivers . . .

During non-working periods the Plessey E.M.U. ensures freedom from annoying 'background' noise—but such is its sensitivity that a signal exceeding the noise by as little as ½dB will unmute the receiver to full signal reception. This sensitivity is adjustable—by potentiometer control—to a point where a signal plus noise-to-noise ratio of 12dB is necessary to unmute the receiver output for both R/T and W/T reception.

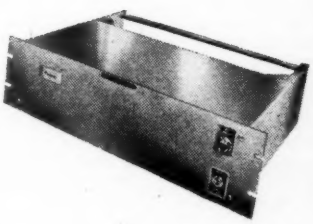


...and the V.H.F. Aerial Multicoupler PV95A

This unit will eliminate clusters of aerials and their attendant siting problems. It provides aerial outputs for up to six receivers when fed from a single Broad Band V.H.F. aerial in the band 100-156 Mc/s. Cross couplings are reduced to a minimum.

The low noise factor coupled with high gain, ensures that the unit causes no deterioration at low signal levels and with the majority of receivers effects an overall improvement in performance. The risk of intermodulation between strong signals is negligible.

The operation of these Plessey units is unaffected by wide temperature variations as all components are fully tropicalised.



For technical details and data, Communications Planning Engineers are invited to request copies of Plessey Publication No. 842 regarding E.M.U. PV97A and No. 783 regarding Aerial Multicouplers PV95A.

THE PLESSEY COMPANY LIMITED, ILFORD, ESSEX

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Plessey is always ready to design and manufacture similar types of equipment to meet specialised specifications.

ELECTRONIC & EQUIPMENT GROUP

EE3a

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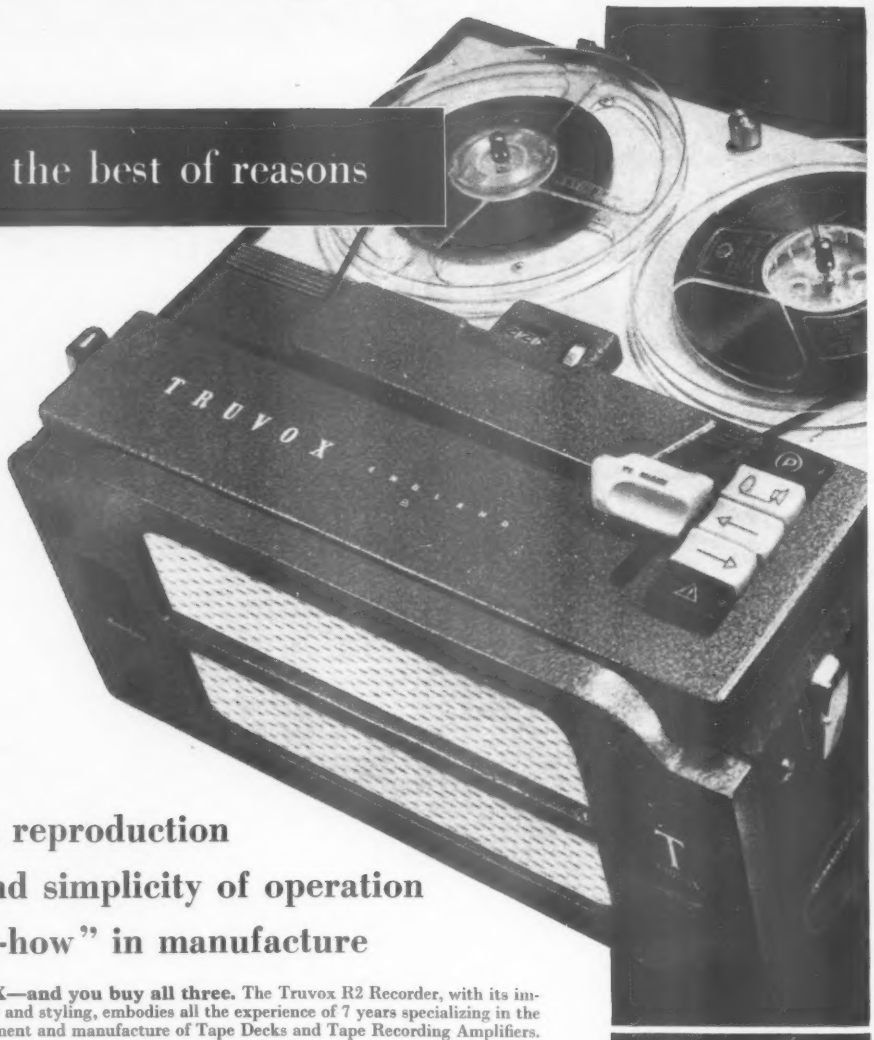

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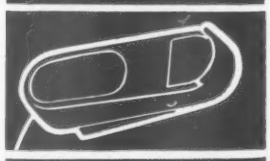
★ **"Know-how" in manufacture**

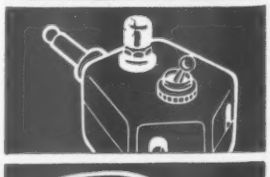
buy TRUVOX—and you buy all three. The Truvox R2 Recorder, with its improved circuitry and styling, embodies all the experience of 7 years specializing in the design, development and manufacture of Tape Decks and Tape Recording Amplifiers. There are no last minute "mods"—every stage has been tested and tested again to ensure that it lives up to the reputation enjoyed by the name it bears.

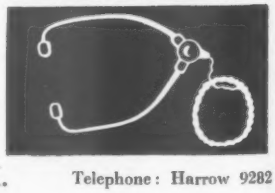
The result is a high fidelity instrument that will give you endless hours of enjoyment producing and replaying your own recordings as well as providing perfect reproduction of pre-recorded tapes with all those finer gradations of tone that are there for those who can hear the difference.

Additional applications of this machine, with accessories, include dictation and transcription, radio reception, telephone conversation recording, AM or FM Tuner amplification, etc.

When you buy TRUVOX you buy a better recorder—produced *for those who can hear the difference.*







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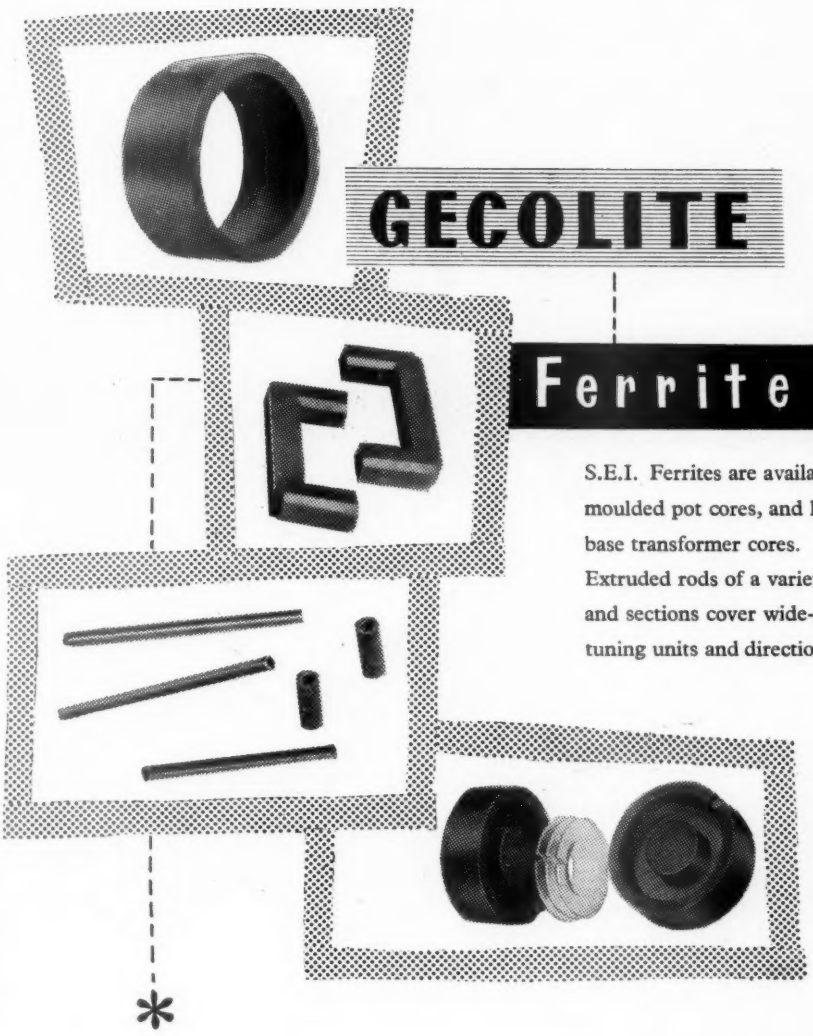
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A simultaneous dual-channel tape recorder

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The first frequency changer valve specially designed for printed circuit turret tuners

The use of printed circuits in television turret tuners offers attractive advantages both from the quality and performance of the product and the reproducibility of performance. Printed circuits, however, limit the scope of wiring connections mainly to two dimensions instead of the three dimensional freedom of normal wiring and the existing connections of frequency changer valves are not very suitable for use with the existing cascodes. In order to realise the expected improvement in performance both the basing connections of the pins and the internal connections in the valve have to be optimised. The new Ediswan Mazda 30C13 has been specially designed to overcome these problems and give improved performance in gain and stability, particularly in Band III. Samples and preliminary technical information on the 30C13 will be available at an early date to Set makers only. Our Application Laboratories will be pleased to discuss your problems.

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Measures frequency up to 50kc/s.
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More comprehensive at the price than any equivalent equipment.
Self checking on five frequencies.
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Incorporates 106 transistors in 19 plug-in stages.
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Variable display time from ½ sec. to 5 sec. or infinite.
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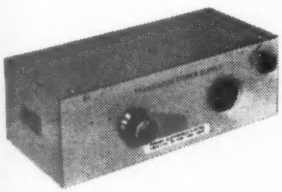
Standard output frequencies at 0.1c/s., 1c/s., 10c/s., 100c/s., 1kc/s., 10kc/s.
0.1 second, 1 second and 10 second sampling times.
Size: 14½ x 17¾ x 11½in.
PRICE £275

TRANSISTOR STABILIZED POWER SUPPLY TYPE TS20

This unit can be fitted inside the frequency meter to enable it to function from EITHER 200/250 v., 50c/s mains, or from 12 v. D.C. at the turn of a switch.
Another important use for the unit is as a source of 8-12 v. D.C. (adjustable) at currents up to 300mA., for use in laboratories, educational establishments or for driving other transistorized equipment. Bench units are fitted with terminals. Size: 7½ x 3½ x 2½in.
Price £20.



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★ INCORPORATES AN ENTIRELY NEW TYPE OF TIME BASE
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AND MATERIALS HANDLING CONVENTION

Earls Court, London, 7-17 MAY, 1958

Mechanical handling is today's vital factor in industrial cost reduction.

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64A

New design 50 ohm attenuator

0 to 132 db in 1 db steps— DC to 500 MC

-hp- 355A/B Attenuators

¼ db accuracy full range for low attenuation values. Maximum error at full attenuation 2 db. "One-knob" control. Super compact design—size approximately 2½" x 2½" x 6"

These are characteristics of the new, rugged, simple -*hp*- 355A/B attenuators.

-*hp*- 355A provides 0 to 12 db in 1 db steps. -*hp*- 355B provides 0 to 120 db in decade steps. Together, 132 db of attenuation from DC to 500 MC is available, with simplest possible controls, premium accuracy, and no complex setup. A solid-shield 50 ohm connector may be used to interconnect the two attenuators.

These new -*hp*- attenuators have balanced capacities and completely shielded sections. They are enclosed in a sturdy metal case, yet weigh only 1½ pounds.

Ask your -*hp*- representative to show you these practical, minimum-space attenuators this week.

SPECIFICATIONS

Attenuation: -*hp*- 355A, 12 db in 1 db steps. -*hp*- 355B, 120 db in 10 db steps.
Frequency Range: DC to 500 MC.
Overall Accuracy: -*hp*- 355A, ±0.25 db, DC to 500 MC. -*hp*- 355B, ±1 db, DC to 250 MC, ±2 db, 250 to 500 MC.
Nominal Impedance: 50 ohms.
Maximum SWR: 1.2 to 250 MC, 1.5 to 500 MC.
Max. Insertion Loss: 0 at DC, 0.4 db at 60 MC, 1 db at 250 MC, 1.5 db at 500 MC.
Power Dissipation: 0.5 watt average; 350 v. peak.
Connectors: BNC.
Size: 2⅞in. wide, 2⅜in. high, 6in. long. Net weight 1½ lb.
£51 delivered in U.K. plus duty if applicable.

Data subject to change without notice. Prices f.o.b. factory

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hp offers over 350 quality electronic test instruments

THE VALVES FOR J BAND OPERATION

'ENGLISH ELECTRIC'

MAGNETRON TYPE M555

This is a new packaged magnetron for pulse operation in J Band with a peak input power rating of 240 kW. Particular care has been taken to produce a compact, rugged valve for air-borne applications.

THE M555

can be supplied for fixed frequencies within the range 14,000 to 16,500 Mc/s.

KLYSTRON TYPE K343

This is a low voltage reflex klystron for J Band operation with a minimum power output of 20 mW at 350 volts. The moulded base and flying leads specially commend it for high altitude operation. It has mechanical tuning covering the range 12,000 to 14,500 Mc/s.

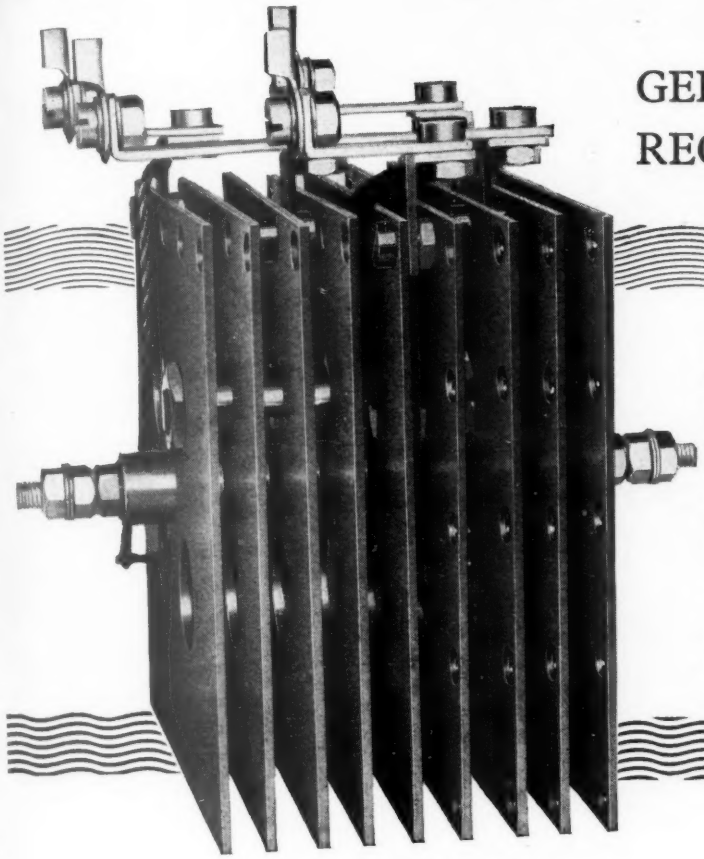
KLYSTRON TYPE K346

This is generally similar to type K343 with mechanical tuning from 14,500 to 17,000 Mc/s.

Both these klystrons, which may be used in conjunction with the M555 or in other J Band applications, have 30 to 80 Mc/s electronic tuning. The output connections are American type UG419/U feeding into No. 18 Waveguide.

ENGLISH ELECTRIC VALVE CO. LTD. *Chelmsford, England*
Telephone: Chelmsford 3491

AP/95



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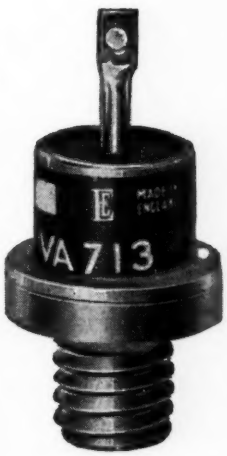
Due largely to advanced crystal perfection techniques and to the generous use of large area junctions, The English Electric Valve Co. Ltd. are able to offer Germanium Power Rectifiers and Stacks with high ratings at 55°C ambient temperature. Standard Stacks cater for all normal single and three-phase circuits.

Stacks are also designed on request to meet individual requirements.

Just a few of the possibilities of one E.E.V. Germanium Rectifier, the VA713, are listed in the table below.

Some Typical Stacked Assemblies

Stack No.	Circuit	R.M.S. Input Voltage per leg (Volts)	D.C. Output (Volts)	D.C. Output Current (Amperes)		No. of VA713 diodes	Approx. overall dimensions (inches)
				55°C.	35°C.		
13E1 13F1 13G1	Single phase, half wave	56 43 28	25 19 12	4·25 4·25 4·25	13 13 13	1 1 1	4 × 4½ × 2½
13E2 13F2 13G2	Single phase, full wave	28 21 14	25 19 12	8·5 8·5 8·5	26 26 26	2 2 2	4 × 4½ × 3½
13E3 13F3 13G3	Single phase, full wave bridge	56 43 28	50 38 24	8·5 8·5 8·5	26 26 26	4 4 4	4 × 4½ × 4½
13E4 13F4 13G4	Three phase, half wave	33 24 16	38 29 19	13 13 13	39 39 39	3 3 3	4 × 4½ × 4½
13E5 13F5 13G5	Three phase, full wave	33 24 16	75 56 38	13 13 13	39 39 39	6 6 6	4 × 4½ × 6½
13E6 13F6 13G6	Six phase, half wave	28 21 14	38 29 19	26 26 26	78 78 78	6 6 6	4 × 4½ × 7½



'ENGLISH ELECTRIC'

ENGLISH ELECTRIC VALVE CO. LTD. *Chelmsford, England*
Telephone: Chelmsford 3491

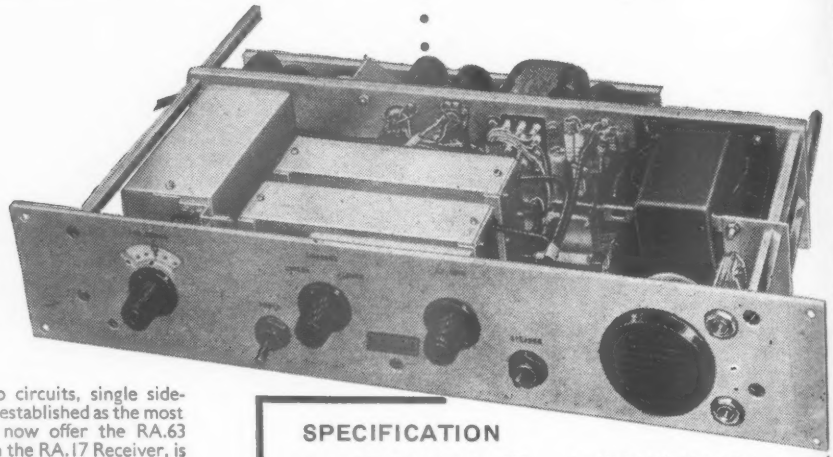
AP/99

RA. 17 COMMUNICATIONS RECEIVER

The impact which the RA.17 receiver has already made upon the communications world is nothing short of sensational. Its circuitry and unique features afford outstanding performance, with exceptional frequency stability and resetting accuracy. Covering a range of 0.5 to 30 Mc/s. *without band switching*, it is most simple to operate—and the range can be extended down to 12½ kc/s. with an LF adaptor.

. . . . . all this

and SSB too . . . . . .



RA. 63

SINGLE SIDEBAND

ADAPTOR

Over long-distance radio circuits, single sideband has now been firmly established as the most desirable system. Racal now offer the RA.63 SSB Adaptor, which, with the RA.17 Receiver, is suitable for both pilot carrier and suppressed carrier systems, and can also be used for SSB reception of double sideband transmission, reducing selective fading effects and allowing adjacent channel interference to be avoided by selecting reception of either sideband.

SPECIFICATION

Service: DSB SSB pilot carrier. SSB suppressed carrier.
Sideband rejection: better than 50 dBs above 500 c/s.
Passband response: ± 5 dBs. 500-3,000 c/s.
Intermodulation products: better than 30 dBs. down
Input frequency: 100 kc/s. ± 1 kc/s.
Input load: 0.05 to 0.5 v. at 75 ohms.
AF output: 100 mW. at 3 ohms. 3 outputs of 6 mW. at 600 ohms.
Dimensions: width 19in. (48 cm.). Height 3½in (9 cm.). Depth 14in. (35½ cm.).
Power Supply: 100/125 and 200/250 v. 50/60 c/s. A.C. Consumption 15 watts.

RACAL Engineering Limited

BRACKNELL, BERKSHIRE

Telephone: Bracknell 941 Cables/Grams: RACAL BRACKNELL BERKS

North England Agent: Farnell Instruments Ltd., Wetherby Industrial Estate, York Road, Wetherby, Yorks. Telephone: Wetherby 2544.

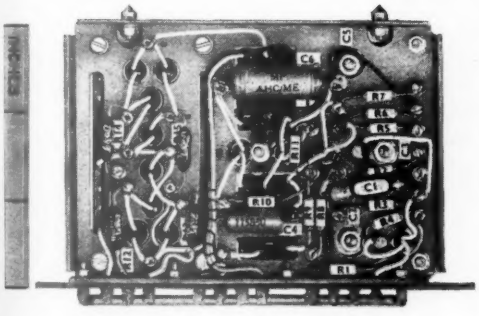
Scottish Agent: A. R. Bolton & Co., 3a, St. Vincent Street, Edinburgh. Telephone: 32035.

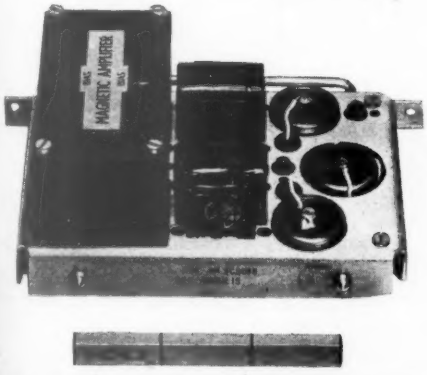
FERRANTI SILICON RECTIFIERS

are used in

ELLIOTT

MAGNETIC AMPLIFIERS





A wide range of applications

Ferranti Silicon Rectifiers are used in Magnetic Amplifiers made by Elliott Bros. (London) Ltd. They were chosen not only for their efficient operation, but also for their complete reliability, robust construction, small size and lightness in weight. Ferranti Silicon Rectifiers have many applications in the aircraft, electronic, electrical and general engineering industries including aero engine controls, aircraft power supplies, radar systems, guided missiles, computers, indicating and recording instruments, process control and telephone equipment.

- ★ LOW REVERSE CURRENT
- ★ HIGH FORWARD SLOPE
- ★ HIGH TEMPERATURE OPERATION
- ★ SMALL PHYSICAL DIMENSIONS
- ★ HIGH MECHANICAL STRENGTH
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for use as a

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OR

TRIPLEXER

THE NEW Y3

FEGD. DESIGN No. 886499

RETAIL PRICE 13/6 COMPLETE WITH STANDARD COAXIAL PLUG

COMPLETE WITH STANDARD COAXIAL PLUG

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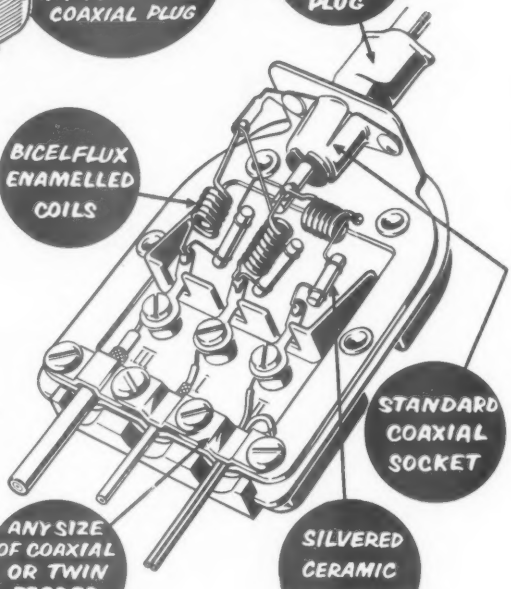

STANDARD COAXIAL SOCKET

ANY SIZE OF COAXIAL OR TWIN FEEDER CABLE

SILVERED CERAMIC CAPACITORS

- ★ High "Q" circuit with all 'open' components.
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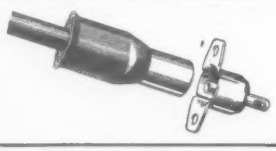
- ★ Easy to connect—standard coaxial socket and cord cable grips.
- ★ Any size of downlead—coaxial or twin feeder cable.
- ★ Fully insulated — resilient 'snap-on' cover.



STANDARD PLUG & SOCKET FOR COAXIAL CABLE

Coaxial Plug, Cat. No. TVP/1
Coaxial Socket, Cat. No. TVS/1

Both 8*d*. *each.*

This new standard plug and socket fully conforms to the R.E.C.M.F. Electrical and Mechanical Specification and whilst it is interchangeable with all similar plugs and sockets, it incorporates many advantages.

ANTIFERENCE LIMITED, AYLESBURY, BUCKS.

Telephone : Aylesbury 2511 (6 lines)

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NEW... COMPACT...

series 320 relay

This relay is of compact design and extremely small for the duty it performs, the contact arrangement is three pole double throw and connections to contact and coil are conveniently brought out at one end of the relay. Contacts and terminations are housed in a high grade Bakelite moulding and the design of the moulding gives increased creepage path and excellent insulation. Guards are fitted to avoid flashover between contacts.

Maximum Working Voltage: 440 volts A.C. 50 cycles.
V.A. Rating: 5 V.A.
Contacts rated up to 10 amperes at 250 volts A.C. or 30 volts D.C.

Series 325 *Relay.* The only difference is that this is a D.C. Relay and the maximum working voltage is 250 volts D.C.
Wattage: 2 watts.
Contacts rated up to 10 amperes at 250 volts A.C. or 30 volts D.C.

MAGNETIC DEVICES LIMITED

Magnetic Devices LTD.
A.I.D. AND A.R.B. APPROVED

MAGNETIC DEVICES LTD., EXNING ROAD, NEWMARKET, SUFFOLK
Telephone: Newmarket 3181/2/3 Grams: Magnetic Newmarket

TELEVISION AND RADIO FOR THE DEAF

The Adaphone unit, which can be connected to any television or radio set, enables deaf people to hear programmes without raising the volume of sound to a pitch that is unbearable to those with normal hearing. What's more, as the Adaphone cannot pick up the other noises in the room, the listener enjoys completely clear reception. The input is matched for 2 to 10 ohms connection and the transformer through which the signals pass has been tested to withstand 2,000 volts D.C. so that the unit can be used with complete safety on both A.C. and D.C. sets. The volume can be adjusted to individual requirements without affecting the volume from the loudspeaker. Tone control is obtained by alternative output sockets, producing either a normal or high response. The Adaphone is normally supplied with a 30 to 40 ohms impedance insert-type magnetic miniature receiver. Alternatively a bone conductor receiver can be supplied at a small additional cost.

MODEL M4 Complete with miniature earpiece, standard earmoulds and leads **£4.19.0**
MODEL M3 Incorporating Automatic Volume Compression, complete as above **£5.15.0**
MODEL M5 With Independent Loudspeaker Switch for Silent Listening, complete **£5.15.0**

The *multitone* Adaphone

Multitone Electric Co. Ltd., 12-20 Underwood Street, N.1. Tel: CLErkenwell 8022

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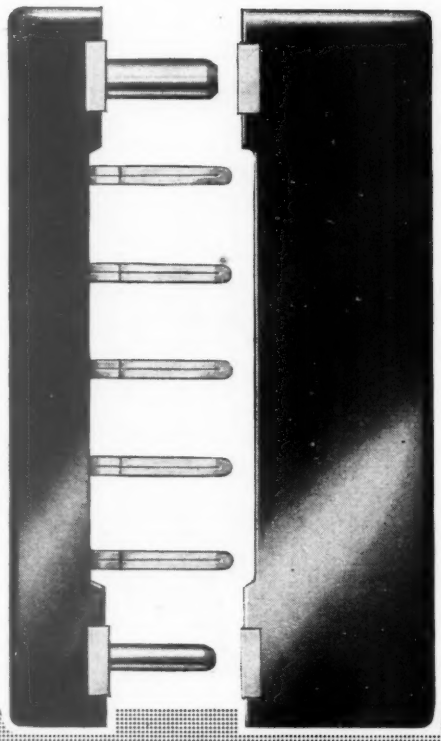


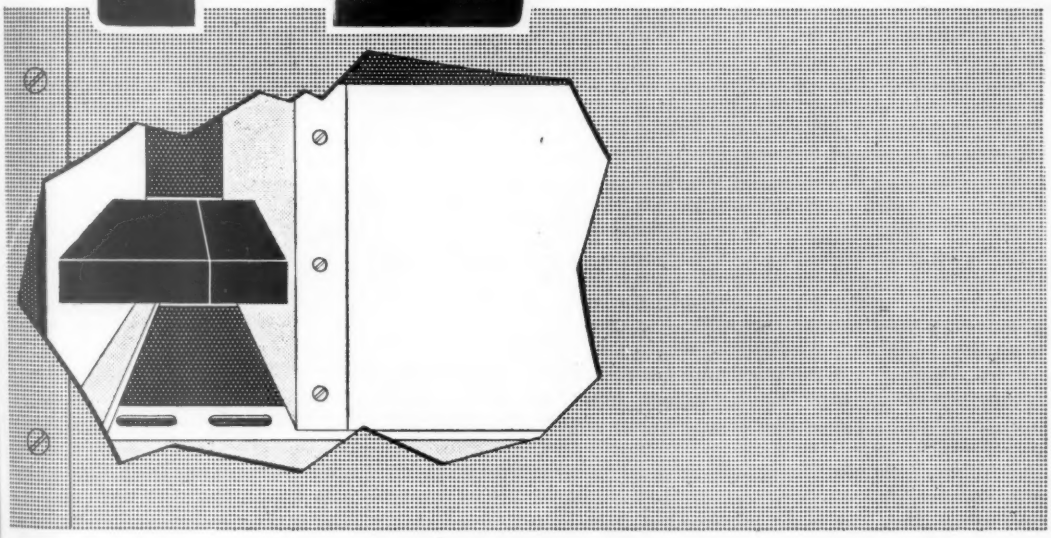
Putting 5 and 5 together

These In-Line Connectors are specially suitable for plug-in unit construction or small rack mounting equipment.

Well proven plug and socket contacts are used and exceptional freedom in dimensional tolerances of fixings etc. has been provided for.

5 and 7-Way versions are available and the Connectors can either be mounted direct to the panel where clearance is provided for contacts or mounted on stand-off pillars.

Location is provided by guide pins which are polarised to prevent incorrect insertion.



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FORMICA industrial laminates, giving exactly defined performances . . . FORMICA industrial laminates, backed by the most wide-awake research and development set-up in this field . . . FORMICA industrial laminates, with a Technical Advisory Service which ensures you get the grade you need, *even if it never existed before.*

Following the formation of the new company they've concluded an agreement for the exchange of technical information with the American Cyanamid Company—covering 25 years and this close link will be invaluable in widening their range, and accelerating technical progress.

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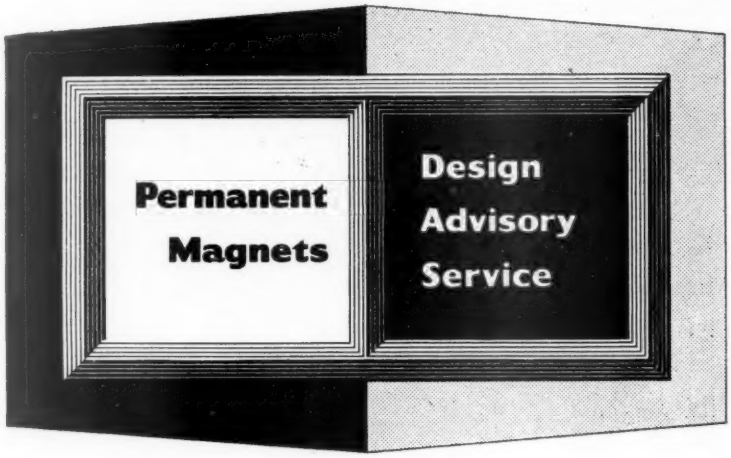

Facilities for technical co-operation in the utilisation of magnet materials

An increasing number of equipment designers are taking advantage of the Mullard Design Advisory Service on permanent magnets. Through this service they can obtain specialist assistance on the selection, design and application of permanent magnets—assistance that will help them ensure optimum magnet performance in the finished equipment. The service is available to all users of permanent magnets, so if you have a design problem just write or telephone the address below: a team of specialist engineers will be at your disposal.

To help with the many day-to-day problems that designers encounter, the Mullard Design Advisory Service is preparing a series of advertisements covering a wide range of subjects from Modern Magnetic Theory to the application of Magnets for Nuclear Research. A new advertisement will be published monthly and each will be readily identified by the symbol shown above. If you would like to collate reprints of the series for reference, just send us a postcard and we will see that you receive them regularly as they become available.

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MAGNADUR CERAMIC MAGNETS
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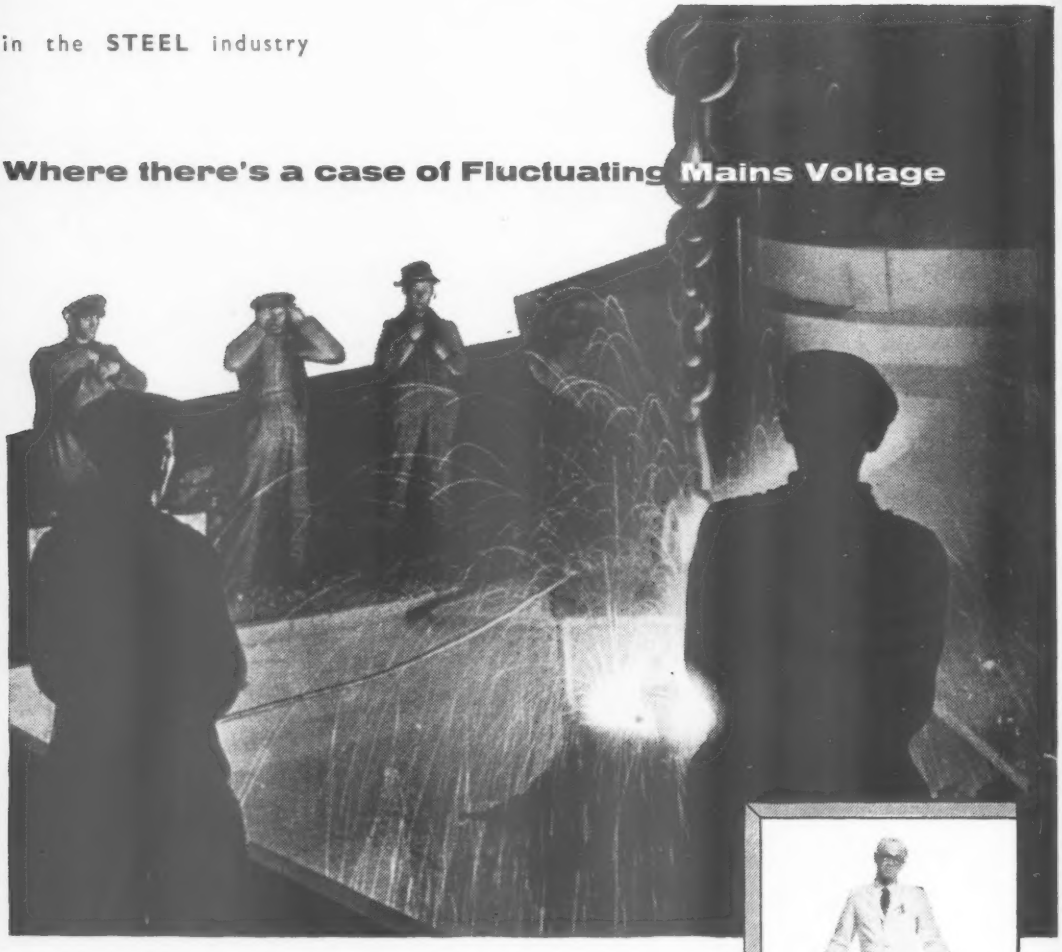
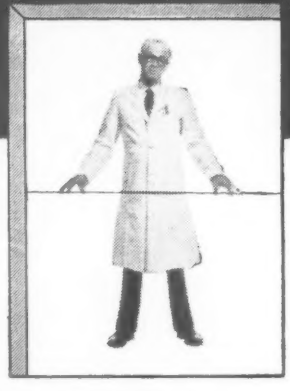
MC260A

in the **STEEL** industry

Where there's a case of Fluctuating Mains Voltage





there's a case for *Advance*

The use of electronic control in Britain's Steel Industry has brought its reward in increased output. But it has also brougnt its own problem. For this vital control equipment must be protected from the a.c. voltage fluctuations caused by the switching-in and operation of heavily motorised machines, otherwise its effective life will be seriously impaired. Moreover, a voltage drop to a servo mechanism could cause chaos on the production line itself. The safeguarding of control gear and processes against supply voltage variations is the function of the "Advance" Constant Voltage Transformer.

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STAND NO.

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"Advance" Constant Voltage Transformers provide a.c. voltage stabilisation of ± 1% for input variations of up to ± 15% at maximum load. For power requirements from 4 to 6,000 watts, they are automatic and contain no moving parts.

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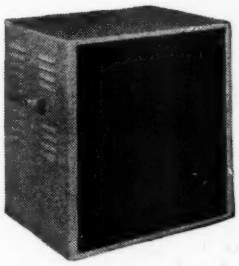
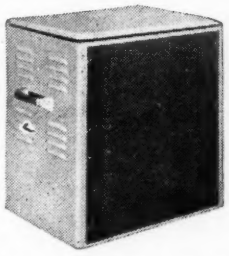
1024 IN THREE SIZES



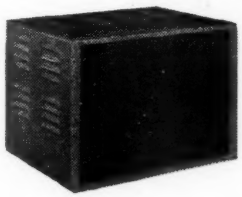
	Width	Depth	Height	Weight
1024A	21⅛"	15⅜"	11⅛"	35 lbs
1024C	21⅛"	15⅜"	22⅛"	43 lbs
1024D	21⅛"	15⅜"	32⅛"	53 lbs

1034 IN THREE SIZES



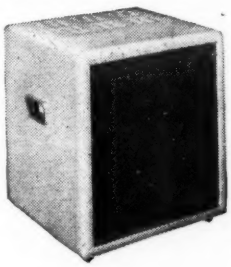
	Width	Depth	Height	Weight
1034A	21⅛"	15⅜"	11⅛"	41 lbs
1034C	21⅛"	15⅜"	22⅛"	48 lbs
1034D	21⅛"	15⅜"	32⅛"	59 lbs

1028 IN THREE SIZES



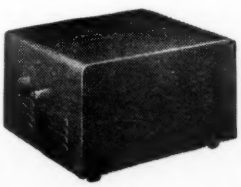
	Width	Depth	Height	Weight
1028A	17⅛"	15⅜"	10⅛"	21 lbs
1028B	19⅛"	15⅜"	11⅞"	25 lbs
1028C	26⅛"	15⅜"	16⅛"	31 lbs

1065 IN THREE SIZES



	Width	Depth	Height	Weight
1065A	22⅛"	20⅛"	14"	47 lbs
1065C	22⅛"	20⅛"	24⅛"	58 lbs
1065D	22⅛"	20⅛"	35"	90 lbs

1063 IN THREE SIZES



	Width	Depth	Height	Weight
1063A	16⅛"	8⅛"	9"	18¾ lbs
1063B	20"	8⅛"	9"	21½ lbs
1063C	16⅛"	14"	9"	26¾ lbs

FIVE SUPERB NEW STANDARD CASES!

AT VERY LOW PRICES FOR BULK QUANTITIES

. . . and every one a perfect match for a fine product! Robustly-made and beautifully finished in every detail, they are typical of the high quality of all Imhof cases. There are now 50 cases in the Imhof standard range which has been carefully planned to suit most case requirements. They are available from stock at 7 days' notice and in any quantity—complete with the handles and accessories of your choice. Special terms for large orders. Save money, time and trouble from now on with Imhofs comprehensive case service. Brochure on request.

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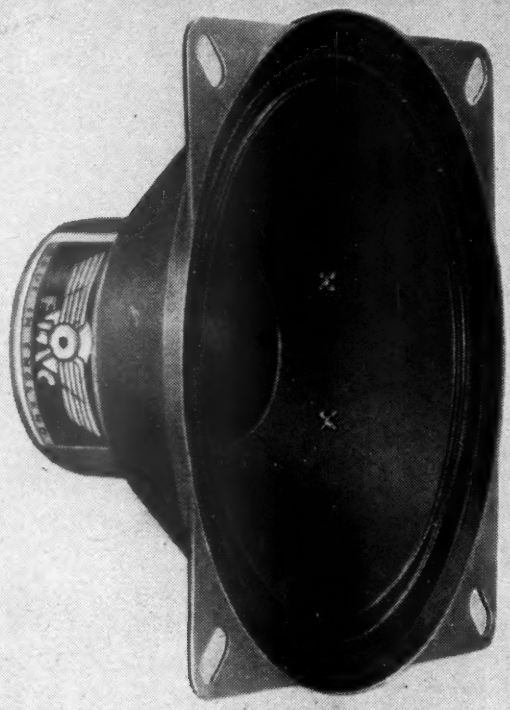

The Elac 4 inch Tweeter

A further addition to the "Elmag" High Fidelity range, this 4in. cone type Tweeter is the finest of its class yet produced. Response to transients is exceptionally good and the absence of undesirable peaks results in clear and smooth reproduction.

For best results it should be used with a suitable cross-over filter in conjunction with 1 or 2 larger units.

Frequency response within 5 dB from 5,000-17,000 cps, only 7½ dB down at 20,000 cps.

OVERALL SIZE: 4in. DIA. x 2⅝in. DEEP.

POWER HANDLING: 2 W. Peak A.D. INPUT.

VOICE-COIL IMPEDANCE: 6 ohms at 5,000 cps.

PRICE: 29/10 inc. P.T.
Trade Terms 33⅓%.

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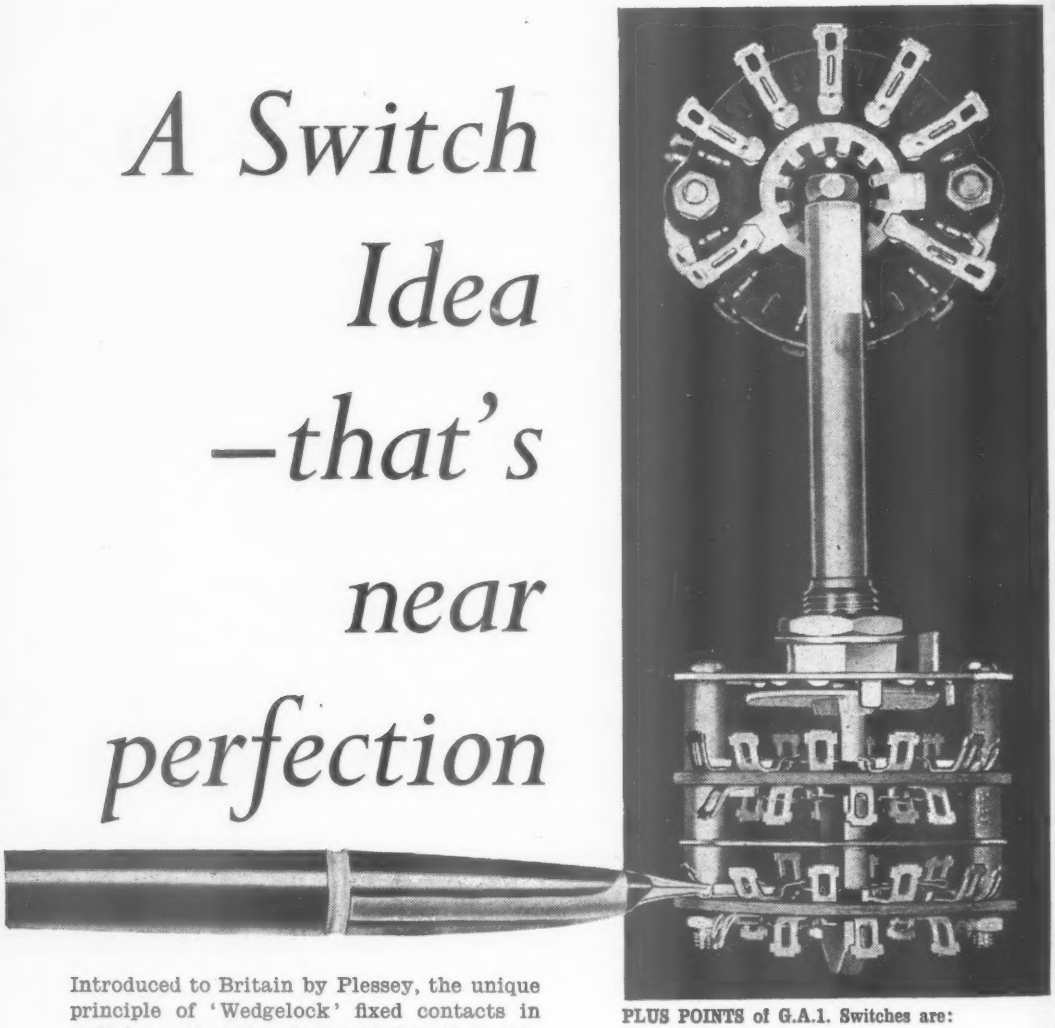
A Switch Idea —that's near perfection



Introduced to Britain by Plessey, the unique principle of 'Wedgelock' fixed contacts in switch construction has gained nation-wide acceptance, and an ever-increasing number of manufacturers are now specifying Plessey 'Wedgelock' Switches for many applications. Contacts are '*Wedgelocked*' into the stators which are securely held to guarantee positive location in all switching positions. Continuous contact efficiency is assured because even excessive tangential pressure will not distort the contact clips.

Design Engineers who have not yet received a copy of the new, comprehensive Plessey Switches Catalogue are invited to send for Publication No. 922.

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- ✳ **Double-wiping, self-cleaning contacts**
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- ✳ **Provision for unusual circuit arrangements**
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ETEL 3AFP-1, M.E.A. ST.37

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Ediswan 30C 3 Series. M.E.A. S.T.31.

Ferranti 5-62, M.E.A. ST.8A G.E.C. 5BHP-1

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5″ Diameter Tube

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ETEL range of instrument tubes

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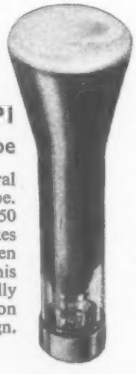
High quality general purpose tube. High sensitivities may be obtained at accelerations of the order of 2kV. Alternatively, high writing speeds may be obtained at 10kV operation.



3AFP1
2¾″ Diameter Tube

Low cost general purpose tube. A drive of only 50 volts on the Y-plates will give full screen deflection. This sensitivity materially simplifies deflection amplifier design.

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1″ Diameter Tube

Small, inexpensive monitor tube. The operating voltage is so low that in most equipment suitable connection to existing H.T. lines is all that is required.

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Specially designed for transistorized instruments, this 2¾″ diameter tube has a low consumption heater and a low focus voltage. The sensitivity is such that deflection voltages may be derived from transistor amplifiers.

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ETL6a

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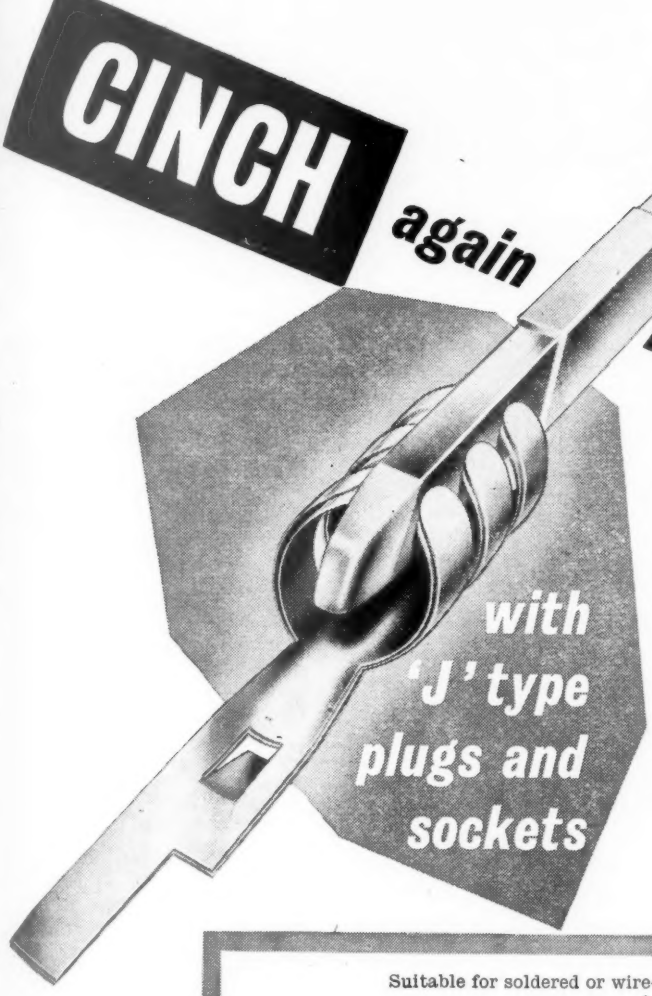
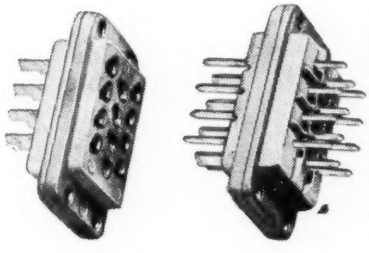


with 'J' type plugs and sockets

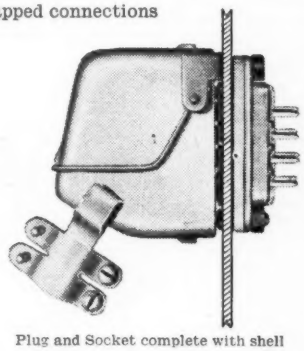
The range of Cinch "J" type plugs and sockets includes 4, 8, 12 and 20 way types. Both plugs and sockets are suitable for cable connecting or for inter-chassis connection as unitors.

The specially designed contacts each have 12 resilient fingers which engage with the corresponding plug blade, resulting in high electrical efficiency matched by consistent smoothness of operation.

Suitable for soldered or wire-wrapped connections



12 way Plug and Socket in Mikacin Moulding



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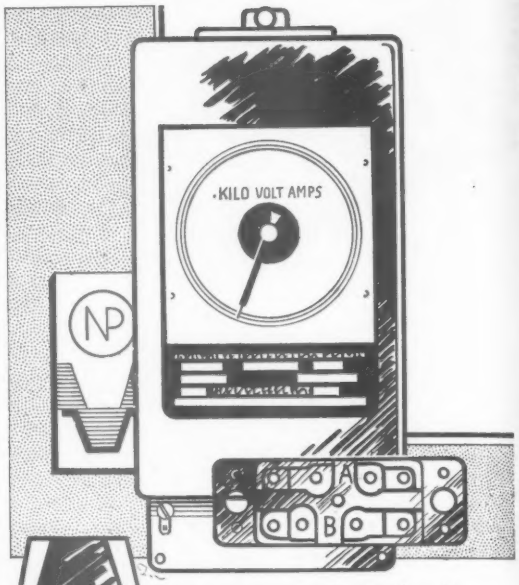

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It is the special job of National Plastics to collaborate with producers of all sorts of industrial equipment, to stick to the problem until it is solved and finally to put the plastics product into swift, large-scale production.

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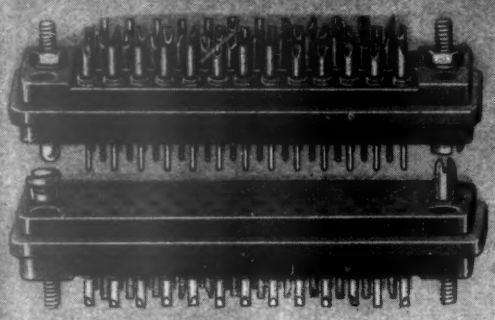

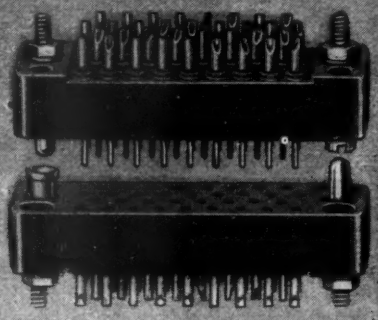

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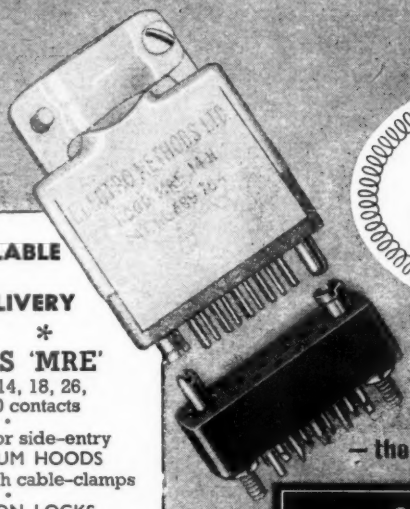

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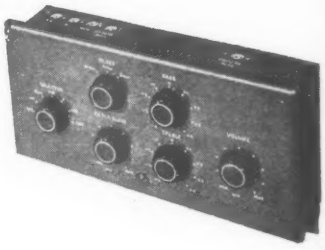

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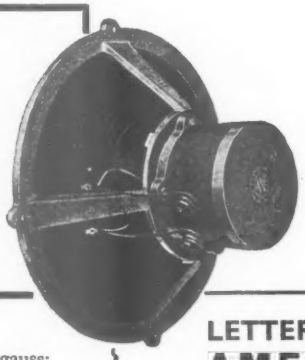

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LETTER FROM AMERICA

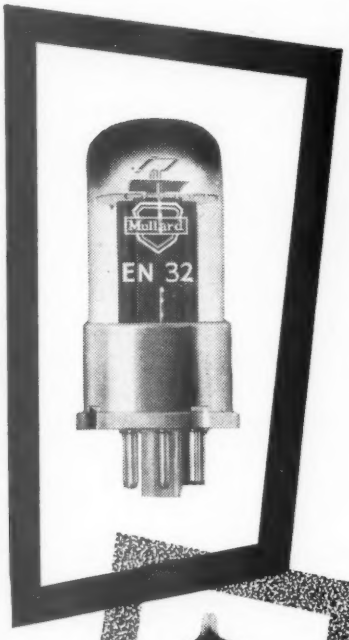
Baltimore,
10 September, 1957

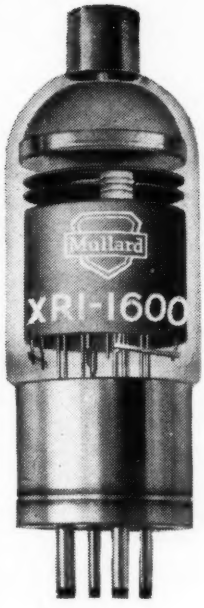
Dear Mr. Briggs,

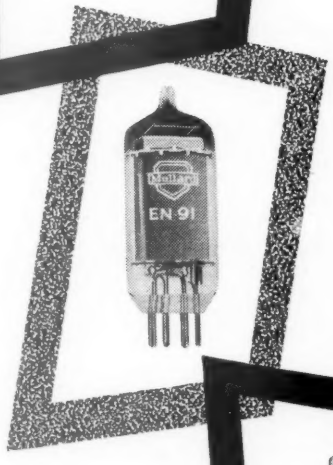
I have not heard anything to match the quality of sound that my sandfilled enclosure and Super 12 speaker can reproduce. I have heard louder systems, but not better tone quality.

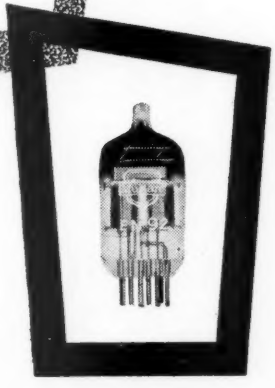
Yours faithfully,

S. M.









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Characteristic advantages of thyratron control are smooth and continuous control of current, negligible control power and high power efficiency.

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MVT 348a

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12" SPEAKER UNIT
Type 1255/15

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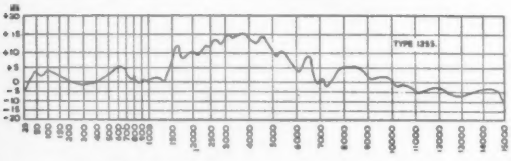
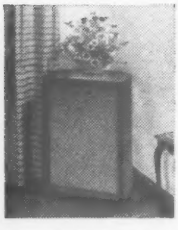
Voice Coil Impedance.....15 ohms
Fundamental Resonance.....40 c.p.s.
Power Handling Capacity.....10 watts
Flux Density: 14,500 lines per sq. cm.
Total Flux: 130,500 lines per sq. cm.



CYCLES PER SECOND INPUT ¼ WATT
RESPONSE CURVE for speaker unit 1255/15



A specially designed reflex cabinet suitable for either corner or side of room is now available as an easy-to-assemble kit of parts, complete with grille material ready to assemble, stain and polish. Although it is primarily intended for use with the Type 1255/15 speaker the cabinet will give excellent results with other units of similar specifications. Price £11

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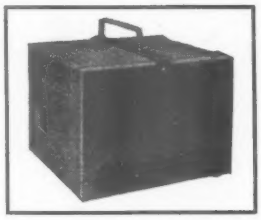

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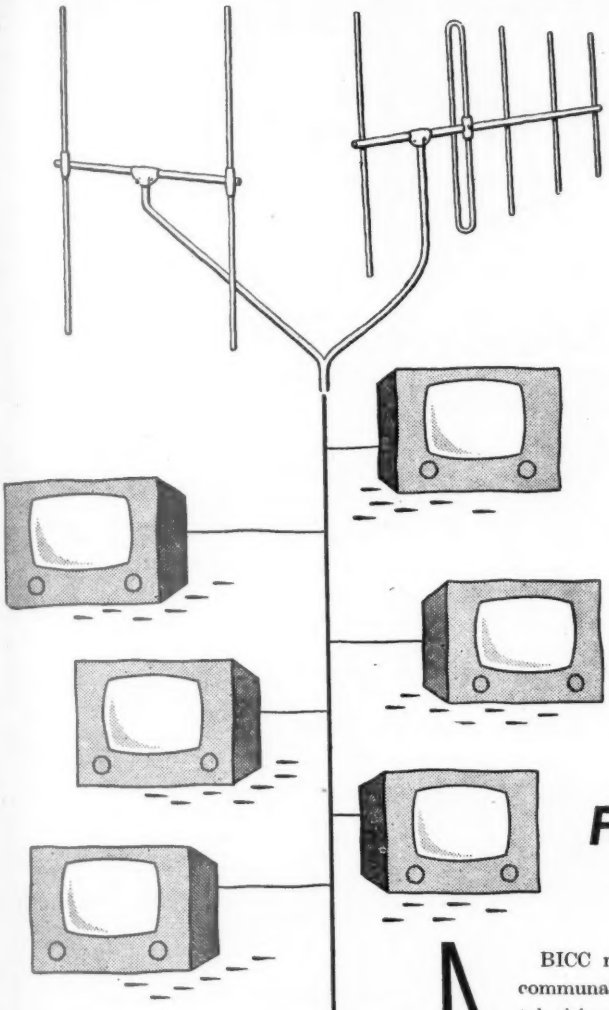

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A rigid vertical rack, plus slotted plates, plus special holder plates. The holder plates are pre-punched to take standard valve holders, potentiometers, switches, terminals, plugs, sockets, meters, etc., and have pronged ends so that they may be slid along the slotted plates. This enables holes to be moved even after assembly and wiring, without disturbing other components. The slotted plates may be assembled in any required arrangement and used to support components, such as tag panels, chokes, transformers, terminal blocks, etc., for which special holder plates are not needed.

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Rapikon enables you to get on with electronic development without frustration from the mechanical considerations of chassis arrangement.

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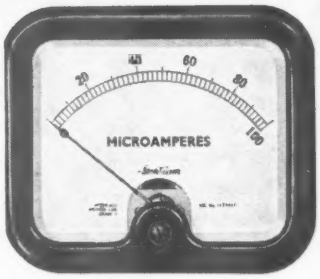

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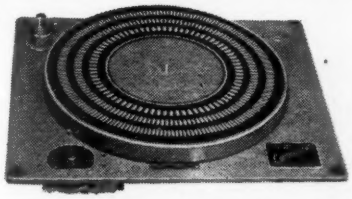

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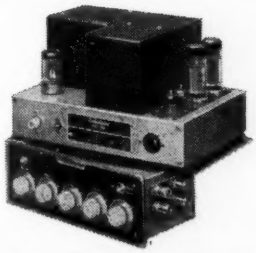
Both units are built to the highest electrical and mechanical standards and incorporate the latest developments in Audio technique. High Power output allows the reproduction of peak passages without overload or distortion.



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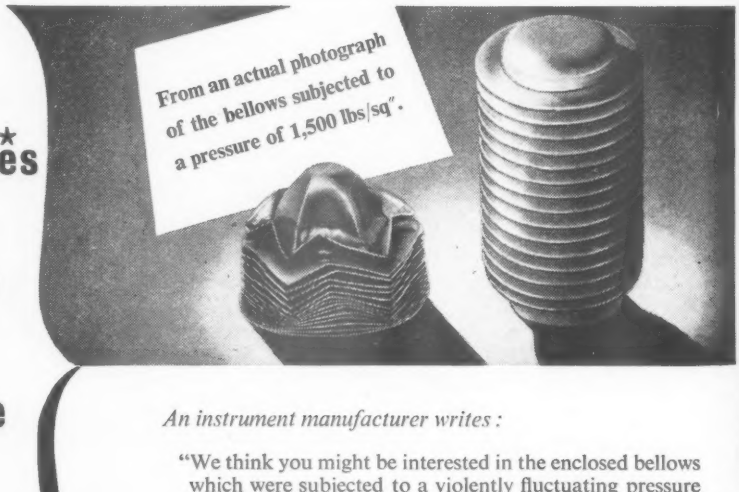

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★ HYDROFLEX metal bellows are suitable for all thermostatic and pressure sensitive applications. Write for List No. N 800-1.

HYDROFLEX

B.17

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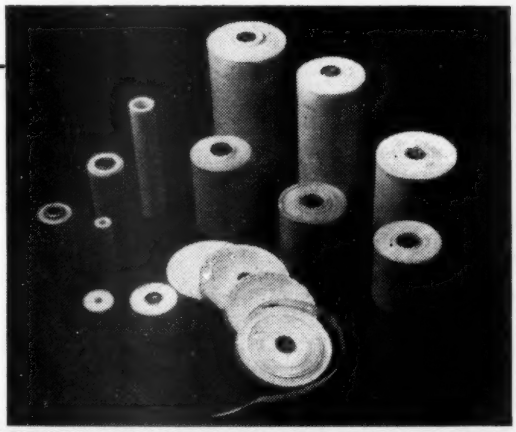

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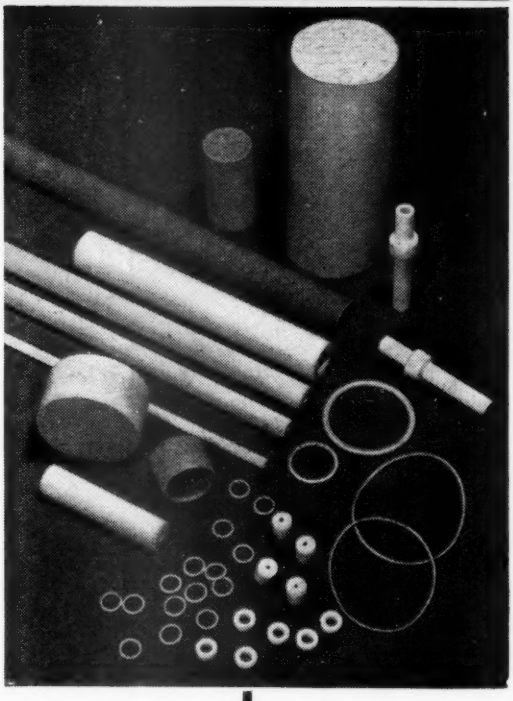
Polytetrafluoroethylene (PTFE)



THIS COMPANY began experimenting with PTFE when it was first introduced into this country. Shortly afterwards we started processing and fabricating the material in a special division of our own factory, giving our own designation of CF2 (derived from the formula) to the range of products ultimately produced.

Since that time, our experience, both of the behaviour of the material itself, during processing, and the application of its remarkable properties has been accumulating.

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THE N.R.S. CONCERT GRAND REPRODUCER KIT comprising

No. 2 Symphony Amplifier *with Remote Control*	£19 19 0
Lenco GL50 Transcription Unit *with transcription quality pickup cartridge*	£21 17 6
F.M. Tuner	£15 15 0
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Concert Grand Reproducer showing layout of deck, Gramophone Unit and amplifier controls.

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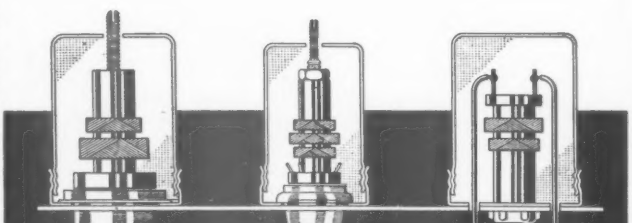

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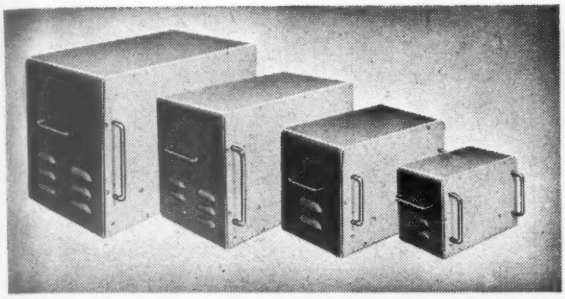

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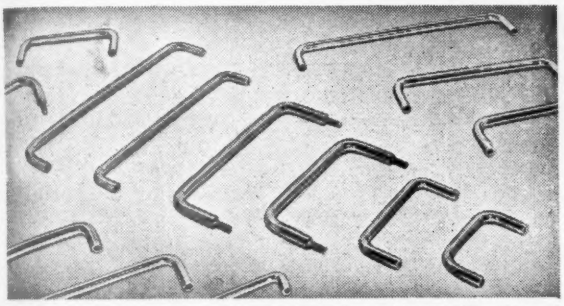

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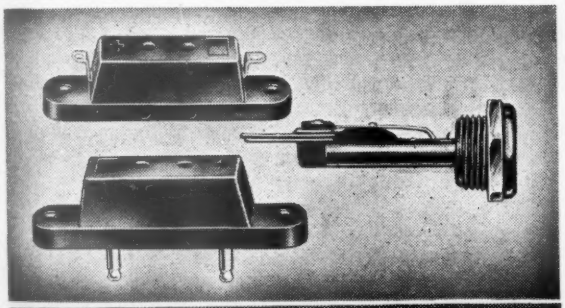

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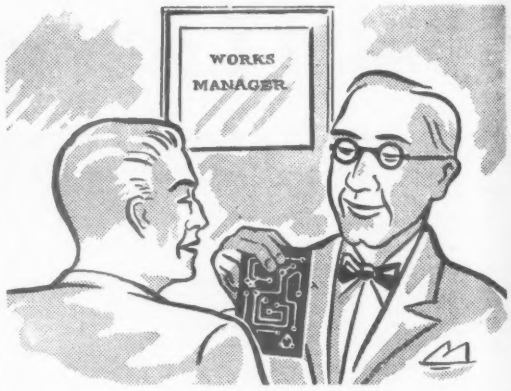

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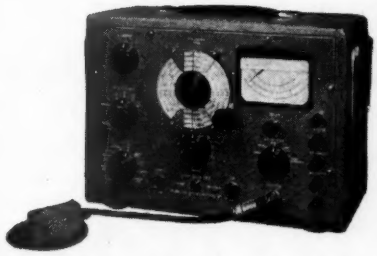
Details of all this apparatus are given in leaflet G105, full of technicalities, so that you, too, can discuss the V.H.F. Test Set authoritatively. You really should send for a copy.



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Type TF 982A

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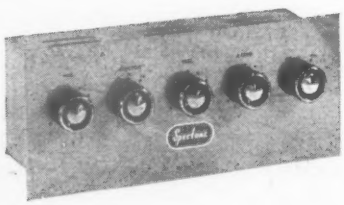

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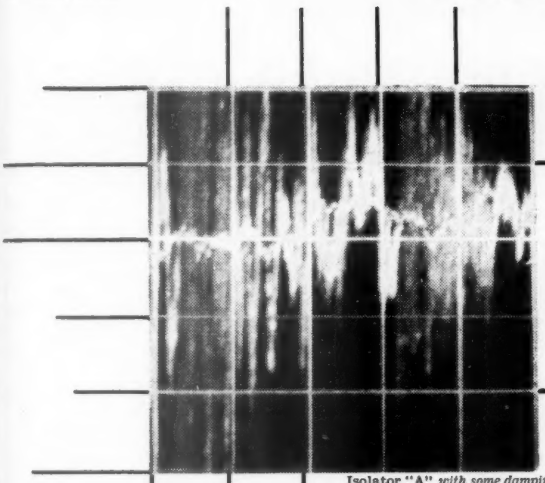
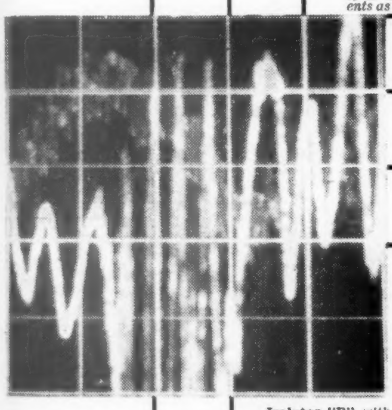


Isolator "A" *with some damping, but snubbing at resonance (15 c.p.s.). Metal to metal impact. Transmitted acceleration approx. 12 g. for sinusoidal input of ±0.026". Envelope contains transients as high as 10,000 c.p.s.*



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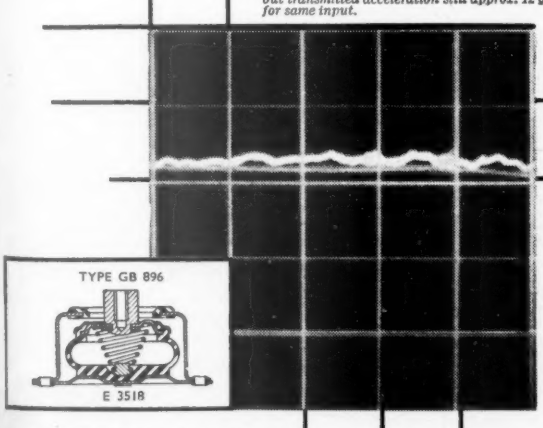

"BARRYMOUNT" Isolator. *Non-linear, air-damped. No snubbing at resonance (8 c.p.s.). Transmitted acceleration for* slightly increased *input (±0.030") is 0.62 g.*

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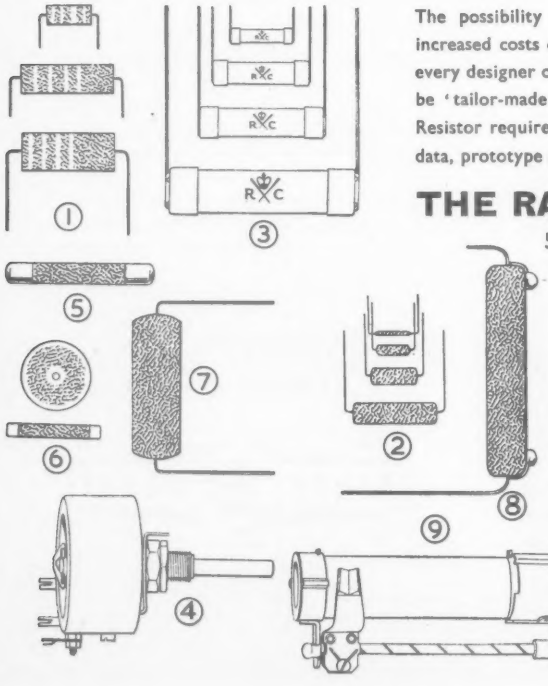

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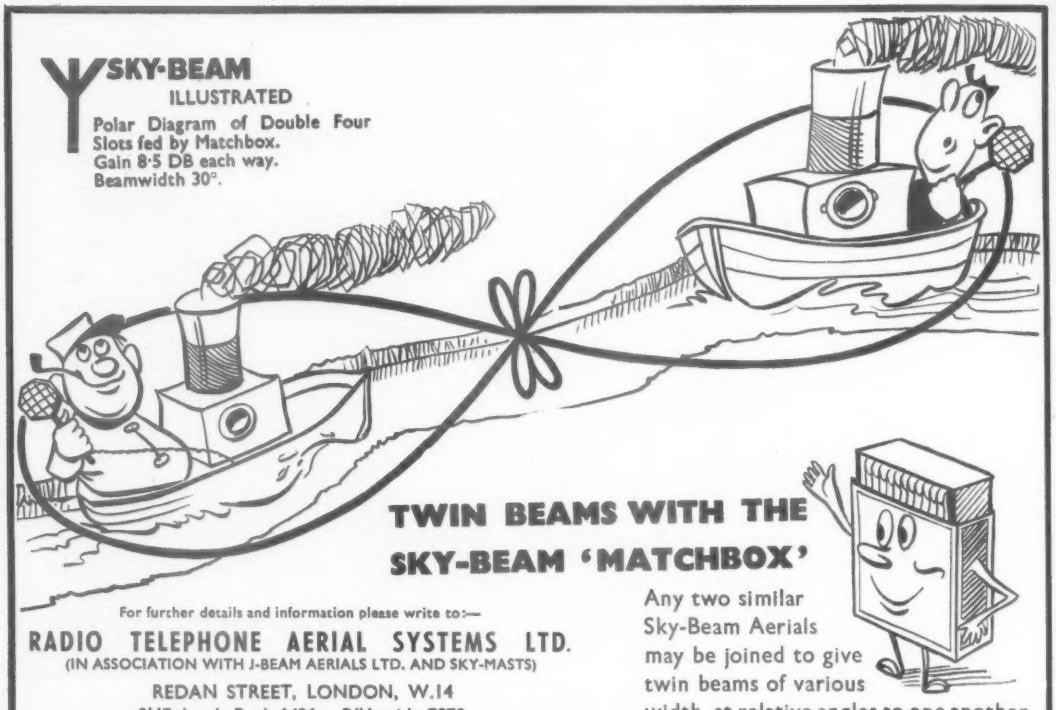

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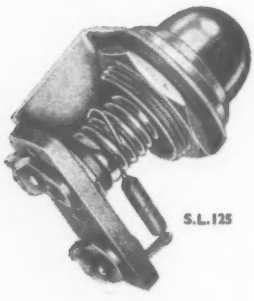
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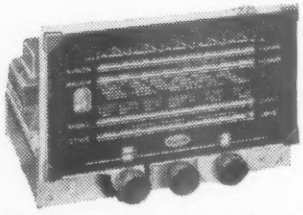

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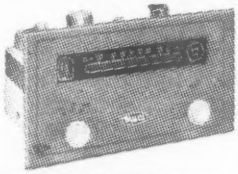

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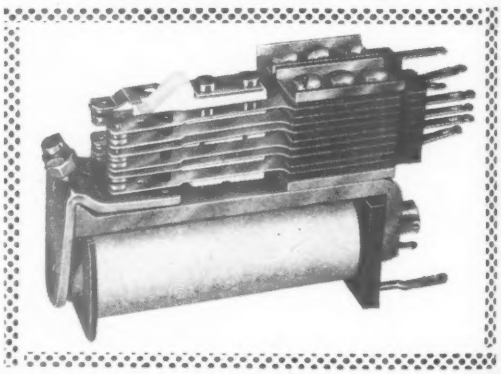

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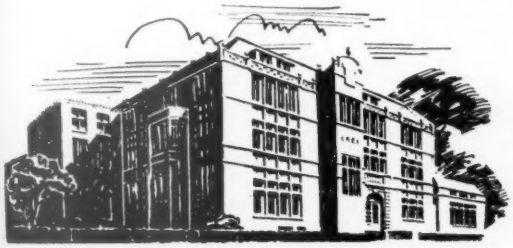

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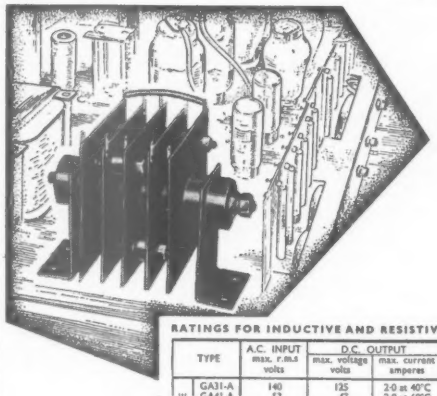

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	GA51-A	210	187	2·0 at 40°C	3¼
	GA61-A	106	94	2·0 at 60°C	3¼
	GA52-A	340	303	2·0 at 40°C	5
	GA62-A	170	151	2·0 at 60°C	5
	GA53-A	510	455	2·0 at 40°C	6¼
	GA63-A	254	227	2·0 at 60°C	6¼
THREE-PHASE	GB31-A	140	188	3·0 at 35°C	4¼
	GB41-A	53	71	3·0 at 55°C	4¼
	GB51-A	210	280	3·0 at 35°C	4¼
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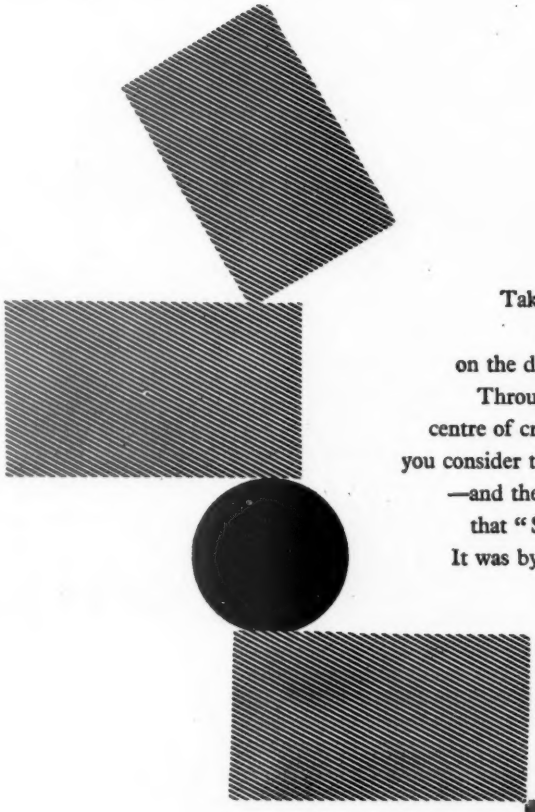

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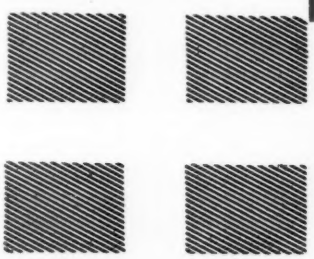

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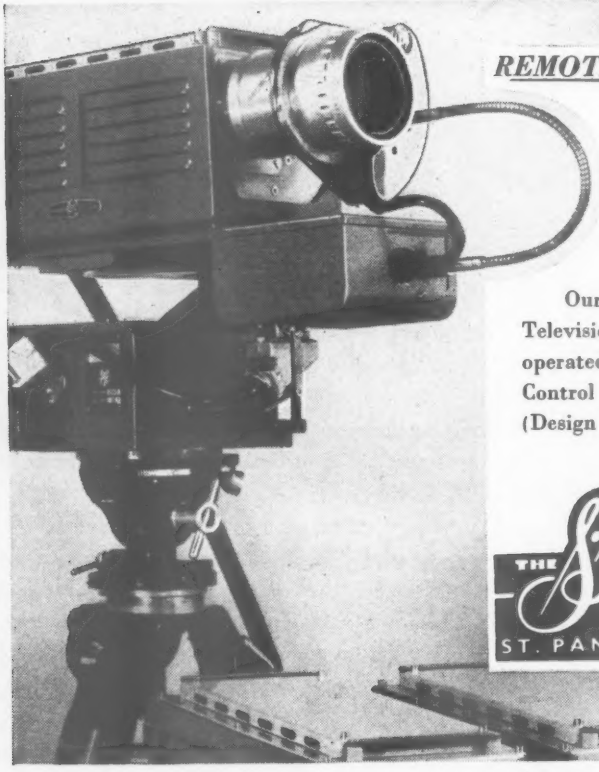

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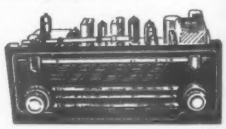

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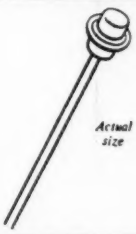

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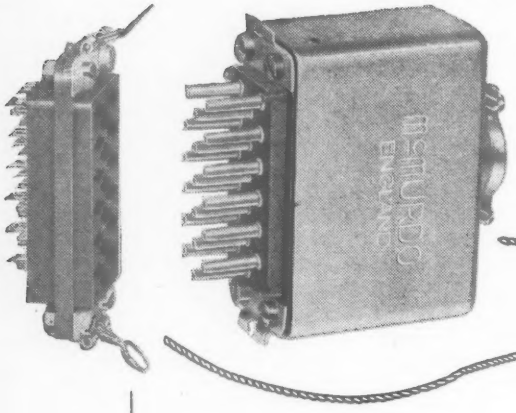

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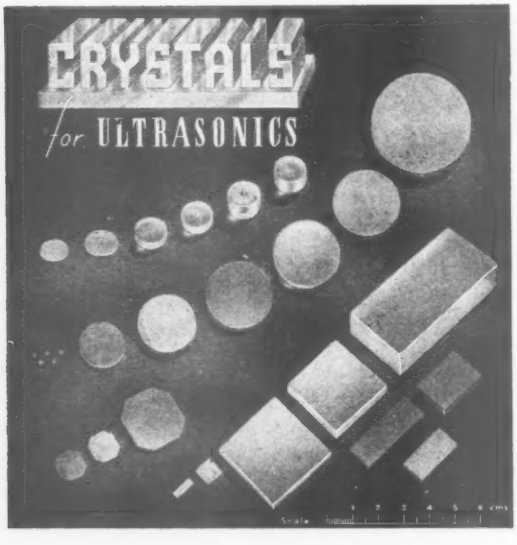

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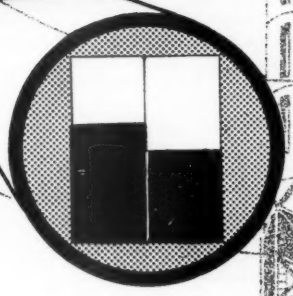

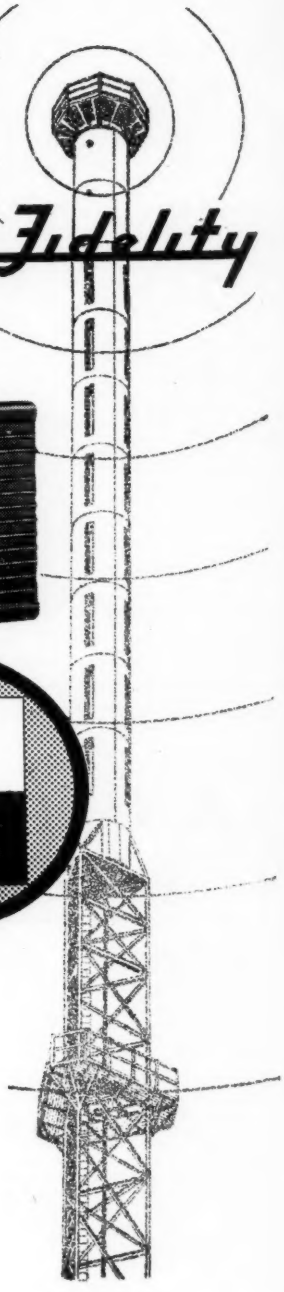

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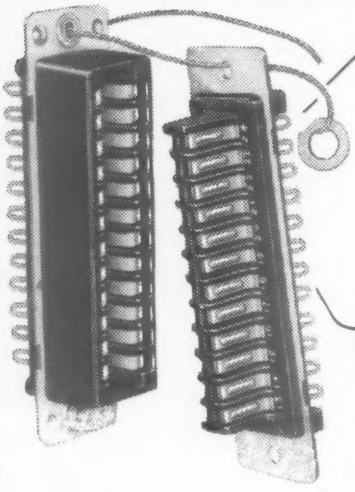

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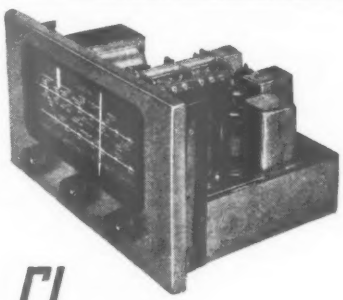

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13 GNS ONLY

MANUFACTURED BY THE MAKERS OF THE FAMOUS STIRLING CONVERTOR

The Cheapest, Most Compact, Most Efficient SELF POWERED FM TUNER on the market

Eliminate all interference and enjoy the B.B.C. VHF broadcasts by simply fitting the Stirling VHF/FM Tuner unit. Designed for use with any radio receiver having pick-up sockets or any record player or amplifier and loudspeaker equipment having a microphone or pick-up input sockets, the tuner is completely self contained, for internal or external fitment. In polished walnut, it measures $7\frac{1}{2}'' \times 7\frac{1}{2}'' \times 2\frac{1}{2}''$.

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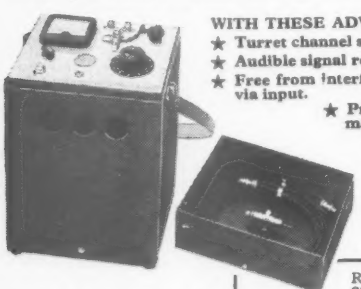
SIGNAL LEVEL METER

Type SL 3/B

A battery operated valve voltmeter for measurement of Television, Television Sound and F/M signals as would appear at the down lead end of Aerial Installation or on Cabling of Wired Television or Communal Aerial Systems.



WITH THESE ADVANTAGES

★ Turret channel selection.
★ Audible signal recognition.
★ Free from interference injection via input.
★ Probe unit for cable measurements with minimum mismatch.

List M3 gives full details and will be forwarded on request.

RANGE: 25 μV to 25 mV in three (attenuator) ranges, or with probe—250 μV to 250 mV. Frequency Coverage: 40—220 mc/s (Bands, 1, 2 & 3).

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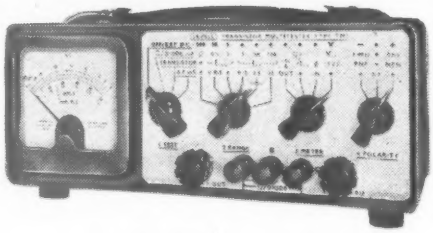
ANNOUNCING LEVELL TYPE TMI

TRANSISTOR MULTITESTER



MEASUREMENT FEATURES

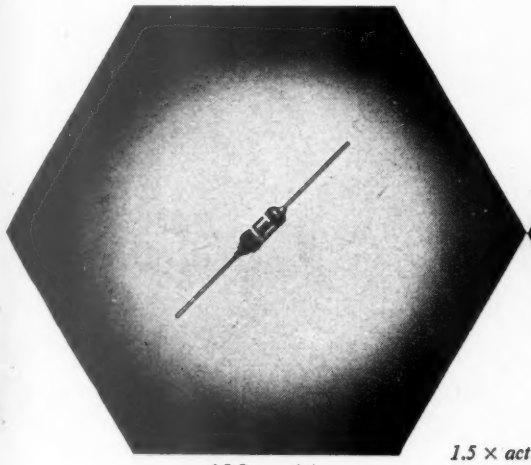
TRANSISTORS PNP AND NPN	I_{CEO} and I_{CBO}: 0/500μA and 0/5 mA f.s.d. β (i.e., CC', h_{fe}') at 1 kc/s: 0/500 at any I_{CE} from 500μA to 500mA.
DIODES	Forward R: V_F at 100μA/100 mA. Reverse I: Down to 5μA at 9V.
D.C.	Resistance: 1Ω to 1MΩ Voltage: 0/5, 0/50, 0/500V f.s.d.
A.F. (150 c/s to 30 kc/s)	Current: 0/0.15, 0/1.5, 0/15 mA. Voltage: 0/150 mV f.s.d. for <0.015 mA f.s.d.
OSCILLATOR	Output: 0/150 mV, 1 kc/s, sinewave, R_O<50Ω.

SIZE: 9½ x 4 x 4in. WEIGHT: 4 lb inc. batteries
DELIVERY: Ex stock. PRICE: £45, batts. 7/6 extra.

DEPT. W.,

LEVELL ELECTRONICS,

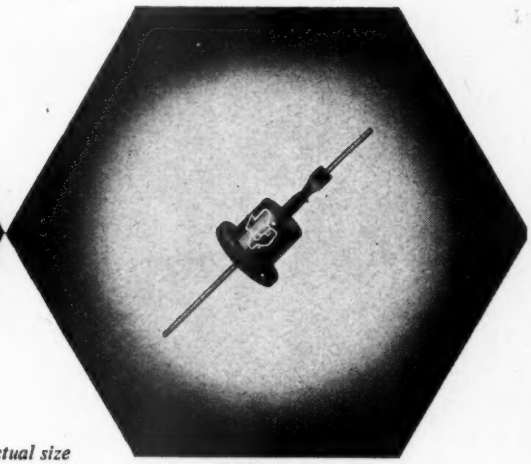
HIGH STREET, EDGWARE, MIDDLESEX. TEL.: EDG. 5708



400 mA

"Moly-G", hard glass hermetically sealed case.
Unit Weight 0.195 Grms.

1.5 × actual size



750 mA

Hermetically sealed metal case.
Unit Weight 1.6 Grms.

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SILICON RECTIFIERS
200—600 volts P.I.V.

These new 'Texas' Diffused Silicon Rectifiers provide you with :—

High current with high voltage
High Forward to reverse current ratio
Wide operating temperature range

TYPE NUMBERS	Peak Inverse Voltage:	200	300	400	500	600 volts
	Moly-G:	1S111	1S112	1S113	1S114	1S115
	Metal Case:	1S001	1S002	1S003	1S004	1S005
				'MOLY-G'	'METAL CASE'	
MAXIMUM RATINGS	Average rectified Forward Current at 25°C			400	750	mA
	Average rectified Forward Current at 150°C			150	250	mA
	Recurrent Peak Forward Current at 25°C			1.25	2.5	Amp.
	Surge Current 1 Sec. D.C. at +25°C to 150°C			3.0	15.0	Amp.
SPECIFICATIONS	Max. Reverse Current at P.I.V. 25°C			0.2	10.0	μA
	Max. Reverse Current at P.I.V. 100°C			15.0	300	μA
	Max. Voltage Drop at I_o=400 mA at 25°C			1.0	1.0	volt

Please write for Data Sheets of these Rectifiers and of our comprehensive range of Silicon Transistors.

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T.2.

Model 1200B. For A.F. and low R.F. applications. Sensitivity 100mV/cm. B/W D.C. to 100Kc/s. C.R. Tube 3in. diam.

Model 2300. Light-weight Portable. B/W D.C. to 2.5Mc/s Sensitivity 50mV/cm. C.R. Tube 3in. diam. Dims.: 7¼x4¼x 7¼ins.

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Will accept wide range of panel thicknesses.

TYPE P **TYPE C**

Very attractive appearance for panel mounting

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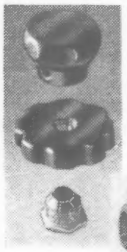

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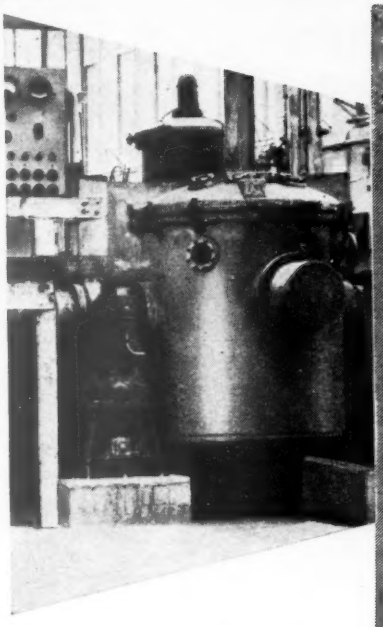

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Mains transformers are available to suit the lower voltage irons.

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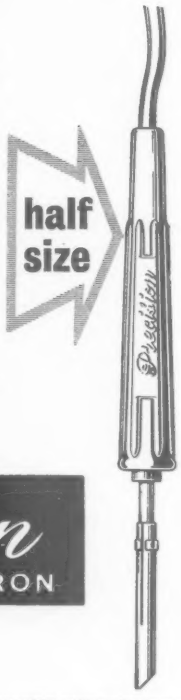

- Complete weight less than one ounce.
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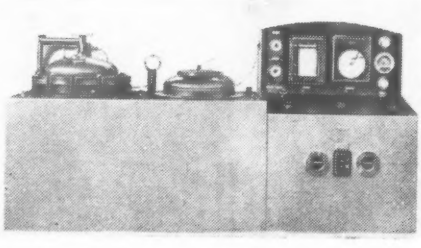

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Experimental I.F. Amplifier by
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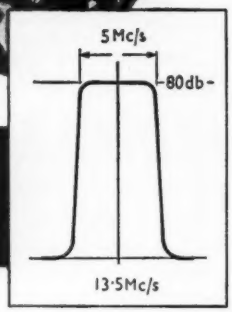

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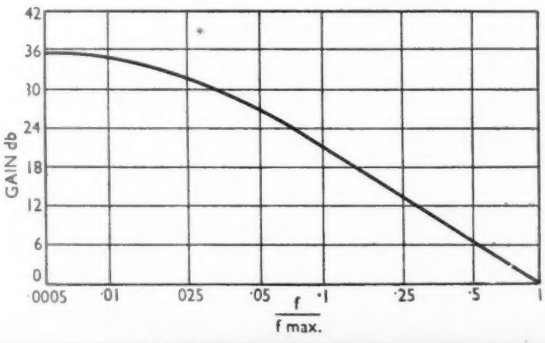

Full technical data and application notes are available on these and any other Semiconductors transistors. Engineers and senior executives are invited to write for copies. Assistance with design problems is freely available.

Production of Semiconductors transistors will commence in mid-1958. Sample quantities are available now.

The curve shows power gain plotted against frequency for Surface Barrier Transistors.

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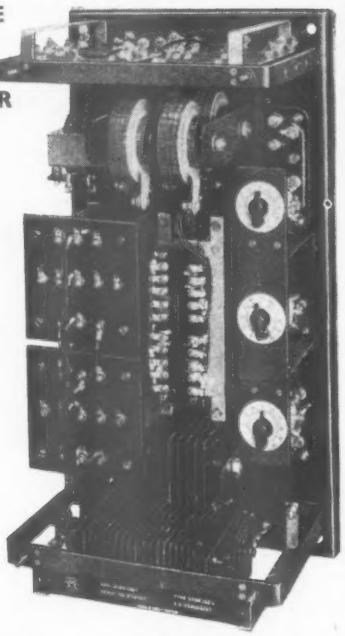

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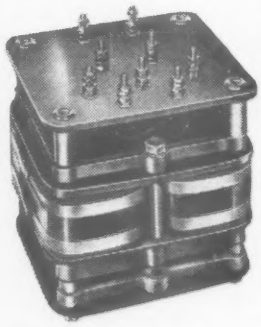

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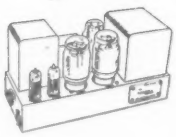

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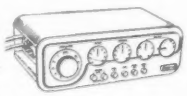

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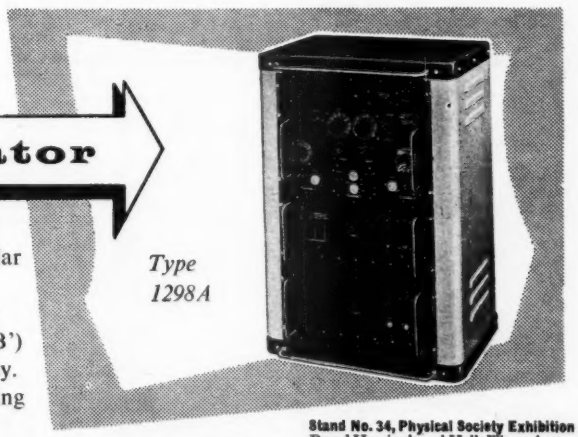
pulse generator

Pulse Generator Type 1298A is designed to produce single and double rectangular positive going D.C. pulses.

The design consists of two independent pulse generators (Channels 'A' and 'B') operated at a common repetition frequency.

A common output (Channel 'C') giving both pulses together is also provided.



Type 1298A

Stand No. 34, Physical Society Exhibition
Royal Horticultural Hall, Westminster
MARCH 24 to 27.

SPECIFICATION

P.R.F.: 50 pulses per sec. to 50,000 pulses per sec.
Pulse Width: 0.1-10μsec. in 20 steps.
'A' and 'B' Pulse Separation: 0-110μsec. dependent on p.r.f. and pulse width.
Amplitude: 'A' and 'B' Channel: 1-100v.
'C' Channel (i.e. 'A' and 'B' pulses):
(a) High output plug 1-50v.
(b) Low output plug 10μv-1v.
Output Impedance: 75 ohms.
Monitor Locking Pulse: Square Wave 40v. pk-pk., positive edge rise time .75μs preceding 'A' pulse by .75μs approx.
Dimensions: 31½" x 19" x 14" (80cm. x 48cm. x 35.5cm).
Weight: 260 lb. (119Kg).

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PG.6

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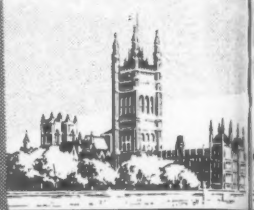

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- ★ Size only 8in. x 8in. x 4½in.
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- ★ Simple to construct, using normal soldering methods.
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1 Valve Amplifier	£2/19/6
7 × 4in. Elliptical Speaker	£1/1/6
B.S.R. TU8 Turntable and Pickup	£3/19/6

This can also be supplied complete with the **Latest Collaro 4-speed Junior Turntable and Pickup** for only £10/12/6 plus 5/- packing and postage.

If any of the individual items are purchased kindly add the postage as follows: Cabinet 3/-, Amplifier and Speaker 3/-, Turntable 2/6.

STIRLING VHF/FM TUNER UNIT

A cleverly designed Unit suitable for installation either in existing equipment or as an external Unit. Completely self contained with its own power supply. The latest type permeability tuned circuit is used, tuning drift being negligible. Size 7¼ × 7¼ × 2¾in. Cash Price £13/13/-. Postage and packing 2/6 extra. Cr. Terms £1/15/- deposit and 8 monthly payments of £1/13/6. Plus postage and packing of 2/6.

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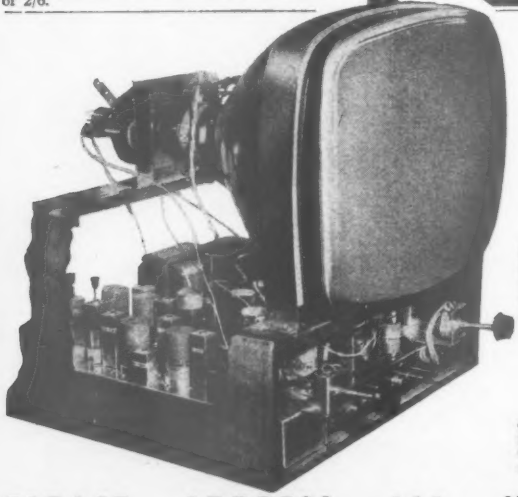

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which gives complete SAFETY to the constructor!

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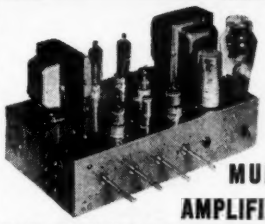

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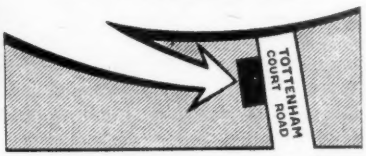

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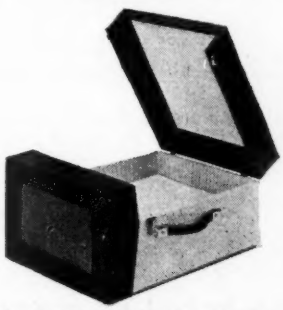

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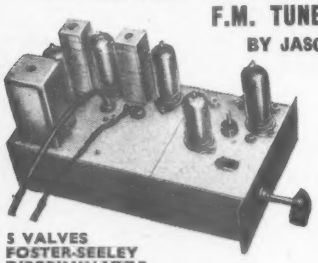

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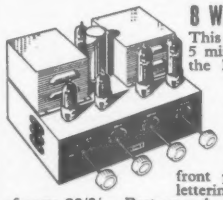

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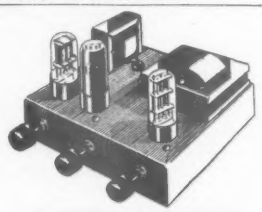

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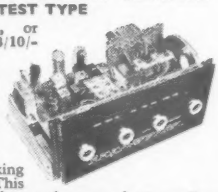

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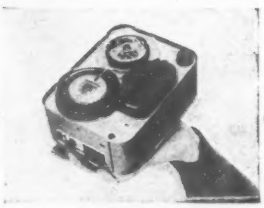

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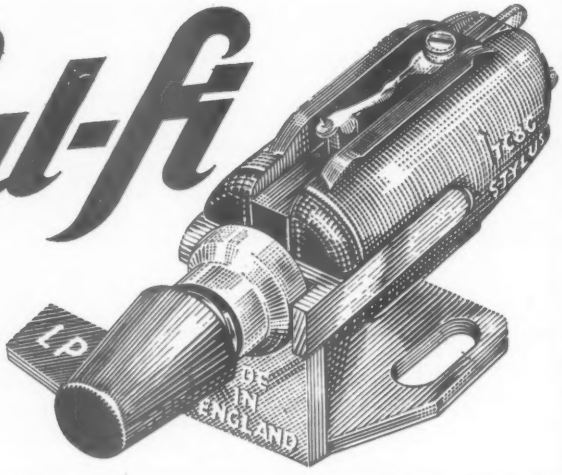

The T.C.8M "Ful-Fi" cartridge is a high-fidelity medium output crystal cartridge, with replaceable cantilever type sapphire needles. Used wherever high fidelity reproduction is desired.

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SPECIFICATION

Equivalent capacity	1,250 p.f.
Output at (1,000 Cps.) at 1.2 cm/sec.	T.C.8M — .3 volts. T.C.8H — .9 volts.
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Load resistance	1 megohm
Weight of cartridge	11 grams.
Stylus pressure	T.C.8M—6 to 10 grams (depending on tone arm construction). T.C.8H—10 grams.

Designed to track when used with average as well as high fidelity pick-up arms and, at the same time, given adequate protection to the finest microgroove recordings when stylus pressure is set within the limits specified. It is advisable to reduce the stylus pressure towards the lower limit, providing the pick-up arm friction in the vertical and horizontal bearings is sufficiently low to allow the arm to track.

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Wireless World

ELECTRONICS, RADIO, TELEVISION

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MARCH 1958

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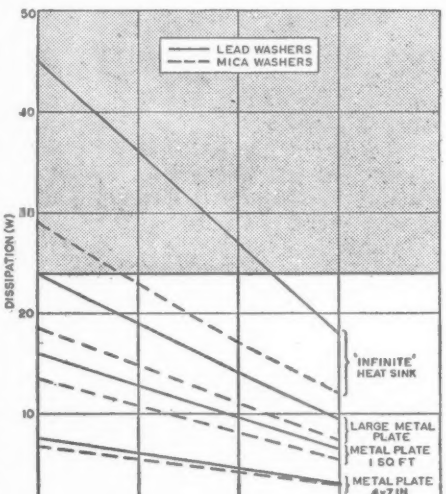
Transistor Heat Sinks for Audio Output Stages

The characteristics of semiconductors are temperature-dependent. If the maximum temperature rating of a diode or transistor is exceeded, the current through the device will rise, the temperature will be further increased, and so on cumulatively to destruction. The maximum temperature rating of a present-day transistor is, in fact, quite high, and in later types it will be higher still; nevertheless, it is necessary that designers should ensure that suitable temperature conditions are provided.

Temperature control is of particular importance in transistor power output stages, because the dissipation at the collector junction of power transistors is itself a substantial source of heat. The problem is well illustrated by the potentially unfavourable lot of the output transistor in a 'hybrid' car radio receiver. The transistor produces heat, and so do the valves; ventilation may be poor; and a parked car (which may be black) can soak up a great deal of heat from outside in summer sunshine. This example is extreme, but it is a useful basis for generalisation. Thus, the designer must consider:

(i) The power dissipation required in the circuit.
(ii) The amount of heat which the transistor will generate at this dissipation level.
(iii) The means of disposing of heat.
(iv) The surroundings, which may either assist or hinder the dissipation of heat.



In a car radio the transistor temperature can be held down in two ways. The transistor can be mounted away from the valves; and it can be provided with a 'heat sink', which is a metal mounting plate which conducts heat away from the transistor and radiates it into the surrounding air. The heat sink can conveniently act as a chassis for the speaker and the whole of the output stage, with a cable connection from the rest of the receiver.

Heat sink design is based on the 'thermal resistance' θ of the metal parts through which the heat flows from the collector junction to the air. The first section of the heat-conducting path is the internal structure of the transistor, with a θ of about 1.0°C/W (Mullard OC16). This means that, for every watt of electrical dissipation, the collector junction will be 1.0°C hotter than the mounting base of the transistor.

Next is the θ of the contact between the mounting base and the heat sink. If the OC16 is mounted in a plain hole and secured with its fixing nut, θ is 0.3°C/W. If the hole is threaded, and thin tin-plated lead washers are used to give good mechanical contact, θ can be reduced towards 0.1°C/W. If, on the other hand, the transistor is insulated from its mounting (say by mica washers), θ may be as high as 0.7°C/W.

The remaining thermal resistances are those of the heat sink itself (its resistance to the spread of heat from the transistor mounting towards the edge), and of the contact between the heat sink and the air. The second of these is a complex quantity depending on surface texture, colour, and air flow. The first is a function of area, material, and thickness. Typical values for the sum of these two resistances lie between 1.5 and 3.5°C/W.

If all the successive thermal resistance values are added together, and the sum is multiplied by the wattage dissipated at the collector junction, the answer is the temperature difference between the collector junction and the air. Thus the junction is held above ambient temperature by that amount. This margin can be reduced by using a heat sink with lower θ and by providing suitable surroundings.

It is possible, in some industrial installations, to use a large thick heat sink in conjunction with water-cooling. Such an arrangement is known as an 'infinite' heat sink, and it allows the transistor to operate (for a given dissipation) with minimum temperature rise above ambient. But this is an ideal which is obviously not attainable in normal practice.

A suitable heat sink is necessary to keep the junction temperature within limits and thus to prevent thermal runaway. It may also allow the transistor to be operated at a higher dissipation (within its wattage rating) without exceeding the temperature limit. Some possible ways of operating the Mullard OC16 are shown in the graph. Any point on the graph will produce the maximum rated junction temperature of 75°C. Thus, with a 'large metal plate' and an ambient temperature of 35°C, a dissipation of about 19W will produce a junction temperature of 75°C. If the ambient temperature is 45°C, then 14W will do the same thing. If, with this ambient temperature, mica washer mounting is used, then heat drainage is less efficient and a dissipation of only 11W gives 75°C. The 'infinite' heat sink is so efficient that no less than 45W is necessary to raise the junction temperature to 75°C when the ambient temperature is 25°C. This wattage is, in fact, well outside the present 24W dissipation rating of the OC16, and is put in only for illustration.

The detailed method of calculating allowable dissipations under various temperature conditions is given in power transistor data sheets. Practical designs of heat sink are based on such calculations and on temperature measurements under actual working conditions.

Mullard
T.S.D. DATA and PUBLICATIONS SECTION, MULLARD LTD., MULLARD HOUSE, TORRINGTON PLACE, LONDON, W.C.1
MVM 387

MARCH 1958

Vol. 64 No. 3

Wireless World

Radar History

WHEN the full and final history of radar comes to be written—and that will not be until many facts are made public which so far have been withheld in this and other countries on real or imagined grounds of "security"—it will be found that development has taken place in several well-marked phases.

First there was the acquisition of the knowledge of the basic physics of electromagnetic radiation, theoretically by Faraday and Clerk Maxwell and experimentally by Hertz.

Then followed the idea of using echoes of wireless waves to reveal the presence of ships and other objects. Although Hulsmeyer was granted a patent in 1904 for apparatus designed for this purpose it could not, with the means then available, have been more than an obstacle detector and does not qualify as a radar system. This may be said of many other re-discoveries of the basic idea during the second phase, which lasted up to about 1935. Some were based on the observed interference effects from reflection of short waves from aircraft, and made use of continuous-wave methods similar to those of Appleton and Barnett for measuring the height of the ionosphere. Others, based on the pulsed ionospheric exploring system of Breit and Tuve, obtained limited success, chiefly on ships at ranges of a few miles. Performances on aircraft were quite inadequate to meet the needs of an early warning system, having regard to the speeds of military aircraft then in service.

The third and most significant phase began somewhere between 1930 and 1935 when Great Britain, in common with all the Great Powers, began intensive development of radio methods of detection. In many countries the work was carried out on an empirical basis and progress, though positive, was slow. Great Britain owes the supremacy which she clearly held at the outbreak of war, first to a sound and far-sighted scientific appreciation of the problem which is epitomized in a memorandum from R. A. Watson-Watt (27th February, 1935) to the Committee for the Scientific Survey of Air Defence. This document, which is reproduced in an appendix to a recently published book.* states the basic power requirements and recommends the use of a pulsed system on frequencies for which the required power outputs and receiver sensitivities could be realized by known techniques. A second and no less important factor was a determination to stick to this programme and to resist the temptation to explore the many attractive side tracks which opened up during the course of the work. As Sir Robert succinctly put it "Give them the third best to go on with; the second best comes too late, the best never comes." The pioneer work of this crucial third phase was carried out by research physicists of the Radio Research Station, D.S.I.R., in collaboration with serving officers of the R.A.F., and the result was an integrated early warning and tracking system which went on 24-hour watch from September, 1938.

By present standards, the world's first radar chain may appear to have had many of the "string and sealing wax" characteristics of the research laboratory, but it was a vital factor in the winning of the "Battle of Britain" which, amongst other things, permitted the development of a fourth phase—the collaboration of the radio and electronics industry with Government scientists in bringing to fruition the many promising ideas which had been put "in the ice box" during the struggle for survival. This collaboration, which had already begun in the erection of the chain stations, continued until the end of the war and produced the sophisticated devices which were put into operation from six months to two years ahead of anything our enemies could devise in retaliation.

The fifth phase, the application of the radar arts to peace—including speed traps for motorists and the tracking of satellites—is still an open chapter.

The future historian should be grateful for the wealth of scientific, military, and biographical detail which Sir Robert has poured out in this book, but he will have to devise his own equivalent of a radar system for finding the way to the facts he wants. When he chooses, Sir Robert can write with crystal clarity, but too often he indulges a weakness for the tortuous allusion which tests the reader's memory of what has gone before or must await something which is to come later. This is a book which cannot be skimmed; it must be read the hard way.

* "Three Steps to Victory," by Sir Robert Watson-Watt (Odhams Press, Ltd.).

Radio Control

INTEGRATED SYSTEM OF SURVEILLANCE RADAR

Decca 25-ft scanner on its tubular steel tower at the Calshot signal station.

DURING the early part of this year a new radio control system and information service was formally brought into use by the Southampton Harbour Board, the inauguration ceremony being performed by the Rt. Hon. Harold Wilkinson, M.P., Minister of Transport and Civil Aviation.

It is an integrated system of high-definition surveillance radar and v.h.f. radio-telephony, which presents the duty operations officer located in the Calshot signal station with a complete "picture" of the movements and positions of all vessels within the port area and its immediate approaches.

The control console, which is shown in one of the illustrations, is crescent-shaped and has three 15-in. radar display units each capable of showing any of the five operational areas which make up the planned coverage of the station. These are Southampton Water, the West Solent, East Solent, the controlled anchorage and a general overall picture of shipping from the Needles to the Nab Tower and taking in an area some 2 to 3 miles south of the Isle of Wight.

Radar information is supplied by the Decca high-definition, 3-cm harbour surveillance radar, Type 32, the 25-ft scanner for which is mounted on a tubular-steel structure on the top of the Calshot Signal Station. This aerial is of parabolic section, slotted to reduce windage to a minimum and has a horizontal beamwidth of less than 0.3°. Associated with a pulse length of 0.05μsec it provides a radar display of the highest quality and definition. The comparatively narrow vertical beamwidth of 4° is adopted as a wider one would only be wasteful of power and liable to introduce undesirable rain clutter.

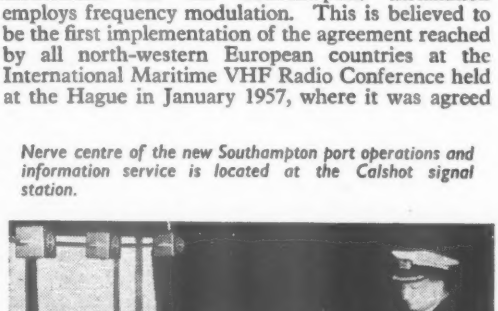
Reliability is ensured by duplicating the radar transmitting and receiving equipment with remote control for immediate changeover in case of emergency. The use of a high-gain aerial enables the required coverage and performance to be achieved with a nominal transmitter peak power of 10kW.

In addition to range rings and bearing graticule centred on Calshot each display tube has one bright, inter-scan line which can be varied in length, bearing and origin and provides a very accurate and convenient method of measuring distances between any two points on the displayed radar picture.

The background information provided by the several radar displays enables the duty controller to pass to ships' masters and pilots information and instructions relevant to the movements of individual vessels and for this the VHF/RT is employed.

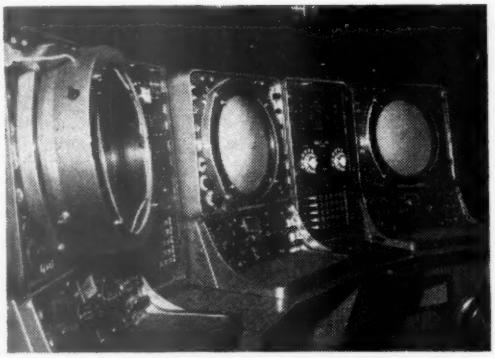
The equipment was supplied by Marconi's and for the shore stations, of which there are five suitably dispersed throughout the harbour area, 6-channel, crystal-controlled sets are used, each remotely controlled from the Calshot operations room and radiating about 25 watts effective power. The frequencies allocated for this service lie in the band 156.3Mc/s to 161.7Mc/s with 156.8Mc/s reserved for calling and safety purposes. Hitherto the majority of v.h.f. marine radio-telephones have used amplitude modulation but the Southampton installation employs frequency modulation. This is believed to be the first implementation of the agreement reached by all north-western European countries at the International Maritime VHF Radio Conference held at the Hague in January 1957, where it was agreed

Nerve centre of the new Southampton port operations and information service is located at the Calshot signal station.



at Southampton Harbour

AND VHF/RT FOR CONTROL AND INFORMATION OF SHIPPING AND AIRCRAFT



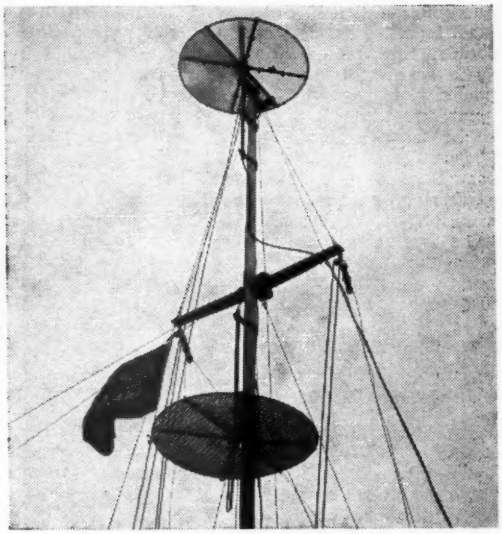
Decca radar displays and Marconi VHF/RT control units in the information room.

that f.m. should be employed for ship-to-shore VHF/RT services. Representatives from U.S.A., Italy and Canada were also present.

The port operations officer is assisted by a patrol officer in a launch, the "S.H.B. Triton," which is fitted with a marine radar, echo sounding and VHF/RT. The patrol launch normally precedes vessels entering or leaving the port to ensure there is no obstruction by small craft in the harbour. The R/T equipment on the "Triton" consists of two 5-channel, 10-watt transmitters/receivers, Type HP86B operated from d.c. Since these are required to operate simultaneously and possibly on adjacent channels, special care has been taken in mounting the transmitting and receiving aerials. These are vertically polarized, ground-plane systems mounted one above the other on the "Triton's" mast and the ground-plane is reinforced by wire mesh. Further isolation is achieved by mounting the unipole of the upper aerial on top of the ground plane and the unipole of the lower below the ground plane, as shown in one of the illustrations.

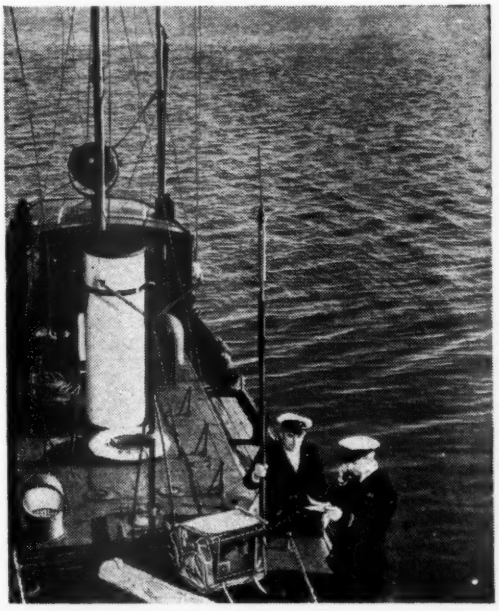
In common with the practice now current at most large airports all radio-telephone messages are recorded on magnetic tape, for which purpose an 8-channel automatic recorder made by Thermionic Products has been installed. Times of all messages, received and transmitted, are recorded for future reference.

Since Southampton is an airport as well as a seaport, close liaison is maintained between the port duty officer in the Calshot control centre and the duty flying officer who is in direct R/T communication with the flying boats using Southampton. Integration of the movement of shipping and aircraft is assisted by fitting the aircraft control launch, "S.H.B. Sharb," with a transportable version of the HP86B R/T equipment operating on the same five channels.



Transmitting and receiving aerials mutually screened by wire-mesh ground planes mounted on the harbour patrol launch "S.H.B. Triton."

Marconi 10-watt transportable radio telephone aboard "S.H.B. Sharb."



WORLD OF WIRELESS

University Scholarships

A NEW university scholarships scheme, providing up to 20 awards each year for boys leaving school or completing their National Service, has been introduced by the English Electric group of companies, of which the Marconi group is part.

The scholarships provide for three years at a university, during which a scholar will receive £450 a year, two years' industrial training (one of which can be taken before entering the university) and two years' experience in a responsible engineering post. Scholars may read for an honours degree in engineering, applied science, mathematics or any technology relating to the engineering industry.

The first scholarships will be awarded by selection in the 1958-59 academic year and applications from boys having obtained a place at a university must be made through headmasters to the Controller of Education, English Electric Co., Marconi House, Strand, London, W.C.2, by March 31st.

Television Show

RESEARCH, rather than domestic reception, is the keynote of the annual exhibition organized by the Television Society and this year's show—the 15th—is no exception. In all 25 exhibitors, listed below, will be participating.

The three-day exhibition (March 4th to 6th) is again being held in the Royal Hotel, Woburn Place, London, W.C.1. Admission is limited to members and the press on the first day (11.30 to 8.0), but tickets for the other two days (12.0 to 8.0 and 12.0 to 7.0, respectively) are obtainable from exhibitors, members and the Society (166, Shaftesbury Avenue, London, W.C.2).

Aerialite
B.B.C.
Belling & Lee
Bush
Chapman & Hall
Cintel
Cossor
Ekco
Ever Ready
Ferguson
G.E.C.
Hallam, Sleigh & Cheston
Livingston Laboratories
Mullard
Murphy
Norwood Technical College
Post Office Engineering
Siemens Edison Swan
Standard Insulator Co.
Telcon
20th Century Electronics
W. Vinten
Wayne Kerr Laboratories
R. W. Wells (Member)
Wolsey Electronics

Audio Fair

TICKETS for the London Audio Fair (Waldorf Hotel, April 18th to 22nd inclusive) are again being issued free through exhibitors and audio dealers. Readers of *W.W.* can obtain tickets from the editorial office. They are dated for specific days and applicants must state the day of visit and, if possible, give an alternative. Applications must be accompanied by a stamped addressed envelope (6in by 3½in).

The Fair will be open daily from 11.0 to 9.0, but admission up to 4.0 on the first day is limited to the trade.

The British Sound Recording Association has decided not to hold its own audio exhibition this year, but will be participating in the Audio Fair.

Export-Import Figures

A RISE of over £3M in the exports of radio equipment during 1957 compared with the previous year, brought the total to a new record of £43.5M. In the following table the export figures (provided by the R.I.C.) for the two years are compared with the import figures culled from the Board of Trade "Trade and Navigation Accounts".

	Exports		Imports	
	1956	1957	1956	1957
Transmitters, nav. aids, etc.	16.5	16.0	2.7	2.7
Valves and c.r. tubes	3.5	3.9	3.0	3.6
Domestic receivers	3.8	3.6	0.4	0.4
Sound reproducing gear	7.6	9.9	—	—
Components	8.7	10.1	—	—
Unclassified radio gear	—	—	3.6	4.1
	£40.1M	£43.5M	£9.7M	£10.8M

It will be seen that exports of sound reproducing equipment and components continued to rise. It has been pointed out that the decline in the export of receivers is to some extent accounted for by the fact that several British manufacturers are now assembling sets in consumer countries and this also accounts for part of the rise in component exports.

The increase in imports was mainly in "glassware". Imports of cathode-ray tubes increased by over 100%, bringing the 1957 total to over £1.6M.

Technical Writing Awards

WITH the object of encouraging technical writing to make more widely known British achievements in radio and electronics the Radio Industry Council awards annually up to six 25-gn premiums.

The recipients of the five awards for articles published in 1957, who will be receiving the premiums at a luncheon on April 10th, are listed below, together with the titles of the winning articles.

E. N. Shaw (R.R.E.) "Heat Control in Electronic Equipment" *Electronic Engineering*, Jan.-Mar.
E. J. Gargini (E.M.I.) "An Alternative Colour TV System" *Wireless World*, Aug.
L. Atherton (Mullard) "Cleaning by Ultrasonics" *British Communications & Electronics*, March.
E. J. P. Long "Speed Control in Industry" *British Communications & Electronics*, Nov. and Dec. and Jan. 1958.
L. W. D. Sharp (Plessey) "Components for Printed Circuits" *British Communications & Electronics*, April.

Forthcoming Events

THE following should be added to the "Dates for your *W.W.* Diary" published in January:—

Production Exhibition — May 12-21
Olympia Grand Hall, London, W.14.
1st European Television Exhibition — May 19-24
Park Lane House, 45, Park Lane, London, W.1.
International Congress on Video Techniques — June 10-13
Namur, Belgium.
French Components Show — June 20-26
Parc des Expositions, Porte de Versailles, Paris.
Electronics Exhibition and Convention — July 10-16
Manchester College of Science and Technology.
Irish Radio and Television Show — Sept. 23-27
Mansion House, Dublin.
Convention of Scientific Instrument Mftrs.' Assoc. — Nov. 6-9
Majestic Hotel, Harogate.

Orkney's Television and V.H.F. Station.—As already announced the B.B.C. proposes to build a combined television and v.h.f. sound broadcasting station in Orkney to serve the Orkney Islands and the northern coast of Caithness. It is considered that the best point from which to relay signals from the main network to the Orkney station is near Wick. The installation at Wick will be designed to provide not only the radio link to the Orkney transmitter but also radiate the v.h.f. sound and television services in Caithness.

Music by Wire.—It is announced that the P.M.G. is prepared to consider applications from individuals and companies for licences to distribute music by wire to business premises, but not to private homes. These licences differ from the Broadcast Relay Licences in that live or recorded broadcast programmes will not be permitted. Licensees will themselves have to provide the wires from the music distribution centres to their customers' premises, but Post Office lines may be rented for linking music distribution centres one with another. The fee varies according to the number of subscribers.

Six-metre operation by selected amateurs in this country in connection with the International Geophysical Year, is being permitted by the P.M.G. for an experimental period of six months. They will operate on 52.5 Mc/s. This is at the top end of television Channel 2 and transmitters in certain areas will, therefore, be permitted to use the frequency only outside television transmitting hours. Further information is obtainable from the R.S.G.B., to whom applications for permission to operate must be made.

Broadcast receiving licences increased by 219,650 during 1957. The December figures, with in brackets the corresponding figures for 1956, were: sound-only 6,892,983 (7,864,030); combined TV and sound 7,760,794 (6,570,097); overall total 14,653,777 (14,434,127).

"Low-Cost High-Quality Amplifier" is the title of the 28-page booklet in which is reprinted P. J. Baxandall's amplifier, described in *Wireless World* in March and April last year, and his pre-amplifiers published in 1955 and 1957. The booklet is obtainable from our publishers, price 3s 6d (postage 6d).

Binding "W.W."—As announced last month, the index to Volume 63 is now available, price 1s, by post 1s 3d. Binding case and index costs 7s 6d (postage 1s 6d). Our publishers will undertake the binding of readers' issues, the inclusive cost being 25s. Copies should be sent to Iliffe & Sons, Ltd., Binding Department, c/o 4/4a, Iliffe Yard, London, S.E.17, enclosing a note of the sender's name and address. A separate note, confirming despatch, together with remittance, should be sent to the Publishing Department, Dorset House, Stamford Street, London, S.E.1.

An instruments exhibition is being staged by Airmec at the Napier Hall, Vincent Street, London, S.W.1, from March 24th to 27th. Tickets are obtainable, gratis, from Airmec, Ltd., High Wycombe, Bucks.

An audio exhibition is being held in the Midland Hotel, Manchester, on March 1st and 2nd. It is sponsored by the British Amateur Tape Recording Society. Admission is 2s.

Symphony de Luxe Tape Recorder, Type A.—We have been asked to point out that owing to a typographical error, the price of this instrument in the advertisement of Northern Radio Services on p. 68 of the February issue was given as 25 guineas. It should have been 52 guineas.

"Design for a Folded Corner Horn" (February issue).—The expression for the reactance of an acoustical volume capacitance given in the second paragraph of the right-hand column on page 60 should be multiplied by ρ. The 34-in dimension in Fig. 5(b) is a radius for the front portion.

Audio Demonstrations.—In addition to the normal programme of lecture meetings held by the British Sound Recording Association a series of demonstrations of audio recording and reproducing equipment is being arranged. The first was held in February, when Dulci equipment was demonstrated, and the next will be on March 3rd at 7.0 at the Royal Society of Arts, John Adam Street, London, W.C.2, when Pilot equipment will be demonstrated.

Radar Association.—It has been decided to include the word electronics in the title of the organization and it is now known as the Radar & Electronics Association. The last meeting of the present session will be held on March 12th in the Anatomy Theatre, Gower Street, London, W.1, when Professor A. C. B. Lovell will speak of the part played by the Jodrell Bank radio-telescope in tracking the artificial earth satellites. Information on the Association's activities is obtainable from 83, Portland Place, London, W.1.

Printed circuit techniques are being covered in the course of 10 lectures given by F. Hicks-Arnold (Cossor) at the Twickenham Technical College on Mondays. The course, for which the fee is £1, began on February 17th.

A concert of live and recorded items, including some stereophony, is being given in the Great Hall of the Blackwell Secondary Modern School, Headstone Lane, Harrow, Middlesex, on March 14th. The audio equipment is being lent by Lockwood & Co., of Lowlands Road, Harrow, Middlesex, from whom programmes price 2s are obtainable. Proceeds are for the school swimming pool.

Personalities

Sir Thomas Spencer, M.I.E.E., who last September completed 50 years' service with Standard Telephones and Cables, has relinquished his position as managing director and is succeeded by **F. C. Wright.** Sir Thomas continues as chairman of the company and its subsidiaries, which include Standard Telecommunication Laboratories, Kolster-Brandes and International Marine Radio Company.

T. E. Goldup, C.B.E., M.I.E.E., this year's president of the I.E.E., and **W. K. Brasher,** I.E.E. secretary, are due to leave London on February 28th to attend the Commonwealth Engineering Conference in Australia in March. On the outward journey they will be attending meetings in Iraq, India, Ceylon and Malaya. After the Commonwealth Conference they will go on to New Zealand and on the return journey will stop in Vancouver and Toronto on their way to the Conference of Engineering Societies of Western Europe and the U.S.A. in New York on April 28th.

A. A. Kay, A.M.Brit.I.R.E., has been appointed assistant chief engineer of the radio and television division of the Plessey Company. Before joining Plessey he was manager of the engineering and development department of RCA Great Britain, Ltd., and previously deputy head of Ultra's radio and television development department.

Alexander Rubach is appointed managing director of Pena Industries' new company, Penco Research & Development Co., Ltd., formed to co-ordinate engineering development and design within the Pena group. Towards the end of the war Mr. Rubach was seconded from the army to the Ministry of Supply for guided weapons research and since 1946 his positions have included those of engineer-in-charge of the electronics laboratory of the Anglo-Iranian Oil Company's Engine Research Section, senior development engineer of All-Power Transformers, where he was responsible for

the engineering, design and manufacture of MOSAIC (Ministry of Supply automatic computer), and head of the experimental engineering department at the G.E.C. Applied Electronics Laboratories, Stanmore.

E. Lloyd Thomas, B.Sc., A.C.G.I., M.I.E.E., has joined R. B. Pullin & Co. as chief development engineer. After obtaining his degree from London University in 1937 he joined Plessey's development laboratory where throughout the war he was mainly concerned with cathode-ray direction-finding gear. In 1945 he went to Sperry Gyroscope Co. as a development engineer, and before leaving them in 1952 was equipment engineer on guided weapon control systems. Since then Mr. Thomas has been chief research engineer with Short Brothers & Harland (Belfast), where he was responsible for the development of the Short analogue computer.

E. L. THOMAS

R. H. MINNS

R. H. Minns, A.M.I.E.E., who for the past 16 years has been in the B.B.C. research department at Kingswood Warren, has joined Hatfield Instruments, Ltd., of Horsham, as technical director. He was at one time in charge of the radio-frequency measurement laboratory of the B.B.C. research department and has done a considerable amount of work on aerial design—particularly v.h.f. and u.h.f. **S. G. Sitton,** who has been manager of the company for the past 2½ years, has also been elected to the board of directors.

Isaac Wolfson has announced that with a view to the development of business at home and overseas, particularly in the United States, he has become the chairman of Collaro, Ltd., which is a member of the G.U.S. Group.

C. Collaro, O.B.E., who, following his resignation from Collaro, Ltd., recently became chairman of Camp Bird Industries, has now succeeded **B. R. A. Homfray Davies** as managing director of the company, and as chairman of Hartley Baird, Ltd., a member of the Camp Bird group. Mr. Homfray Davies resigned from these positions and the joint managing directorship of Hartley Baird at the end of January.

M. H. Evans, A.M.Brit.I.R.E., formerly of the Ministry of Supply and until recently a director of Epsylon Research & Development, Ltd., has formed, in collaboration with **K. W. Shipman** and **G. J. Shipman,** M.A.(Cantab.), K.G.M. Electronics, Ltd., to specialize in precision mechanical and electronic equipment. The general manager is **E. D. Parchment,** A.M.Brit.I.R.E., formerly of the Decca Record Co. and more recently a director of Epsylon Sales and Service, Ltd., and the chief engineer, **D. O'C. Roe,** B.Sc.(Hons.), who was at T.R.E., Malvern, during the war and subsequently chief electronics engineer at Birmingham Sound Reproducers, Ltd. More recently he was with Epsylon Research & Development, Ltd., and S. E. Opperman, Ltd.

W. West, O.B.E., B.A., M.I.E.E., who recently retired from the Post Office Research Station, where he had been staff engineer since 1946, was well known in the field of electro-acoustics. He had been chairman of the acoustics group of the Physical Society and the acoustics committee of the International Organization for Standardization and of the electro-acoustics committee of the Medical Research Council. During the war he was responsible for the design and production of emergency and permanent radio stations for both overseas and internal civil and military communications. His original work in electro-acoustics included the free-field calibrations of microphones and the design of the first artificial ear for measuring the response of telephone receivers. He had been in the Post Office for 35 years.

OUR AUTHORS

Dr. W. D. Cussins, whose article on the mechanics of electronics is on page 133, is in charge of the service department of Cussins & Light, the well-known electronics and electrical firm of York, which he joined in 1953. From 1944 to 1947 he was at Cambridge where he took the two parts of the mechanical sciences tripos, obtaining a first in both parts and the Charles Lamb Prize for the best performance in electrical engineering. He then spent two years in the E.M.I. research laboratories on research on high-power klystrons before returning to Cambridge to undertake research for his Ph.D. degree. His thesis was on the effects of ionic bombardment on germanium.

E. Moston Kenny, who describes a system for suppressing the "bright spot" which appears on television tubes on switching off the set, is engineer in charge of the applications laboratory of Morganite Resistors, Ltd. He was previously a development engineer in Plessey's chemical and metallurgical division. During the war he worked on Army signals equipment and associated test gear at the Inspectorate of Electrical and Mechanical Engineering (M.o.S.), Chislehurst, and was later in the Health Physics Electronics group at A.E.R.E., Harwell.

Clement Brown, author of the article on the magneto-dynamic pick-up, is in the technical-commercial department of Philips Electrical, Ltd., where he is concerned with the development of sound reproducing equipment. Before joining Philips in 1956 he worked on the design and development of high-fidelity products at E.M.I. and Plessey.

P. L. Burton, B.Sc., who, with J. Willis, describes some unusual transistor circuits, has been in the guided weapons division of English Electric since graduating in physics from University College, London, in 1951. His co-author **J. Willis,** B.Sc., joined the division, of which **L. H. Bedford** is chief engineer, in 1953, having spent three years in the R.A.F. after graduating in physics from Imperial College, London, in 1950.

OBITUARY

F. H. Robinson, Comp.Brit.I.R.E., honorary secretary of the Radio Industries Club, died suddenly on January 30th at the age of 56. Known affectionally throughout the radio industry as "Robbie," he had been on the staff of Odhams Press since 1922, first as editor of *The Broadcaster* (now *Electrical and Radio Trading*) and, since the war, as adviser in electrical and radio matters to the *Daily Herald*, *The People* and *Sporting Life*.

John Hytch, for many years a senior member of the press and publicity department of the B.B.C., which he joined in 1927, died on February 9th, aged 59. Since his retirement from the Corporation in 1955 he had been London representative of the Irish journal *Radio Review*, and latterly was adviser on broadcasting to the Gas Council.

Unusual Transistor Circuits

By P. L. BURTON, B.Sc., Grad.Inst.P., and J. WILLIS*, B.Sc., Grad.I.E.E.

Gating, Limiting and Other Operations, Mainly for Pulse Work

MOST electronic circuits can be based equally well upon valves or transistors, but there are some where the special properties of transistors are particularly advantageous. We have set out to describe a few such circuits here, concentrating on physical explanations of circuit action and the main features of design rather than on rigorous mathematical treatment.

Voltage Catching Circuits.—The diode voltage "catching" or limiting circuit is probably quite well known to many readers. However, its action is worth describing briefly, the better to compare it with its transistor counterpart.

A typical circuit is that of Fig. 1. A resistor R_L is fed with a varying current I. To prevent the

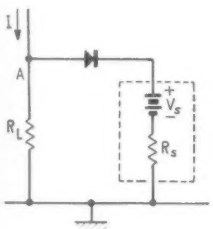


Fig. 1. Diode voltage catcher.

potential of A (at the upper end of R_L) from appreciably exceeding a given voltage V_s a diode is connected from A to a source of potential V_s. When the current exceeds the critical value $I_s = V_s/R_L$, the diode conducts; the incremental resistance of the circuit measured at A is thus now R_L in parallel with $R_d + R_s$, where R_d is the diode incremental forward resistance and R_s is the internal resistance of the source. Clearly, this must be very much less than R_L if catching is to be effective. Typical values of R_d and R_s are respectively 500Ω (at 1 mA) and 1 kΩ, so effective catching cannot take place if R_L is less than about 15 kΩ.

The transistor catching circuit is shown in Fig. 2. So long as the current I is less than I_s the emitter of the transistor is at a lower potential than its base, so the transistor is cut off.

As soon as the potential at A becomes slightly greater than V_s, however, the transistor conducts and places an incremental resistance $r_e + (r_b + R_s)(1 - \alpha)$† in parallel with R_L. Typical values for 1 mA emitter current are $r_e = 20\Omega$, $r_b = 1000\Omega$. $(1 - \alpha) = 0.02$, so for a voltage source resistance of R_s of 1000Ω the resistance placed in parallel with R_L is 60Ω, a twenty-five-fold improvement over the diode case. Note that the current diverted from R_L mostly passes out through the collector of the transistor, which is taken to a suitable negative supply. (The presence of current in this lead may be used as an indication that catching has taken place.) For similar performance to the diode circuit, R_s can be much larger. If R_s is much greater than r_b, the incremental resistance of the catcher becomes $R_s(1 - \alpha)$, i.e. about $0.02\,R_s$, so that from this point of view R_s is limited only by the maximum acceptable incremental resistance. A further limitation, however, is imposed by the collector leakage current I_{co} which flows through R_s and makes the effective catching potential equal to $V_s - I_{co}R_s$. Since I_{co} varies rapidly with ambient temperature**, and considerably between transistors, R_s has usually to be chosen to keep $I_{co}R_s$ small over the operating temperature range of the circuit.

It is important to realise that the impedance-transforming property described in the last paragraph arises from the power amplification of the transistor, and hence that the frequency response of the transistor must be suitable for the rise time of the waveform applied to the catcher. If a very fast edge is applied to an audio-frequency transistor, a relatively long time is required for the catcher to operate and overshoot will occur. With the Mullard OC45 the catching is entirely satisfactory with rise-times of about a microsecond.

The circuit shown is of course suitable only for limiting positive voltage excursions. The corresponding circuit for negative excursions, Fig. 3, requires an n-p-n transistor, and, like many other elegant devices, must await their general availability.

Transistor Pump Circuit.—The diode pump circuit is a well-known device for generating a

*English Electric Company.

†Transistor T parameters: r_e = emitter resistance. r_b = base resistance. α = current gain.

**I_{co} doubles for approximately every 10 deg C rise in temperature. A typical figure (Mullard OC71) is 5μA at 20 deg C.

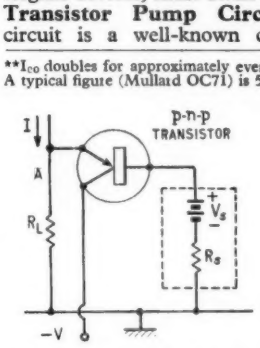


Fig. 2. Transistor voltage catcher. This uses a p-n-p transistor and limits positive excursions.

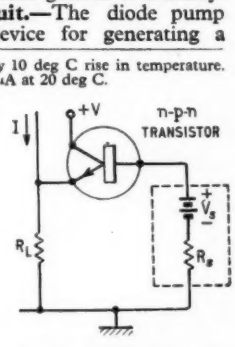


Fig. 3. A transistor voltage catcher using an n-p-n transistor for limiting negative excursions.

staircase waveform from an input train of pulses††. The circuit is given in Fig. 4, and its operation may be briefly described as follows: Suppose that a train of pulses of amplitude V_{in} is applied to the input terminals. Assuming both C_1 and C_2 are initially uncharged, then the negative-going edge of the first input pulse causes D_2 to conduct and C_1 and C_2 to be placed in series across the input. Both receive the same charge, but since C_1 is made much smaller than C_2 most of the voltage appears across C_1. The charge added to each is thus approximately $q = C_1V_{in}$.

On the positive (trailing) edge of the first pulse, the potential of point X rises; D_2 cuts off, isolating C_2 from the input, and D_1 conducts, discharging C_1. Thus, at the end of the first pulse C_1 is once more without charge, but C_2 will have a potential difference across it of approximately $(C_1/C_2)V_{in}$. Thus D_2 is back-biased by this amount. It follows that on the next pulse D_2 will not conduct until the potential of the point X has fallen by $(C_1/C_2)V_{in}$. The voltage shared between C_1 and C_2 this time is thus slightly less, so that not quite so much charge is added to C_2 as on the first pulse. As the upper plate of C_2 becomes more negative on succeeding pulses, the input has to move farther and farther before D_2 conducts, and smaller and smaller amounts of charge are added to C_2; in fact, the envelope of the staircase waveform across C_2 is exponential.

Replacing D_1 by a transistor as in Fig. 5 makes the staircase linear. The action on the leading edge of the first pulse is the same as with the diode pump. On the positive trailing edge, the transistor conducts and behaves as an emitter follower which maintains point X at nearly the same potential as Y throughout the discharge of C_1. Thus on the arrival of the next pulse, D_2 has virtually no reverse bias and the whole input voltage is used to charge C_1 and C_2. The same argument applies whatever the potential across

††For example see "The Diode Pump Integrator," by J. B. Earnshaw. *Electronic Engineering*, January, 1956.

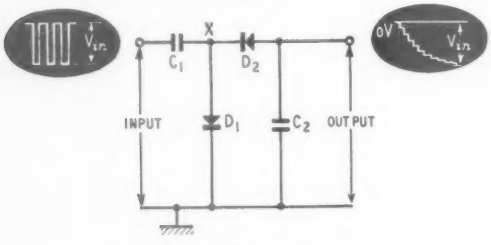


Fig. 4. Diode pump circuit

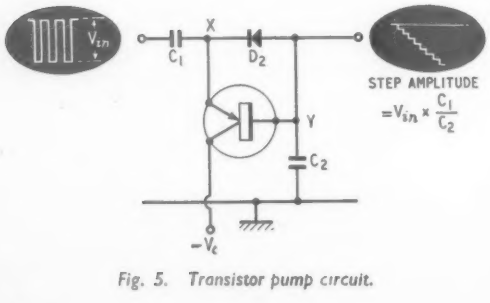
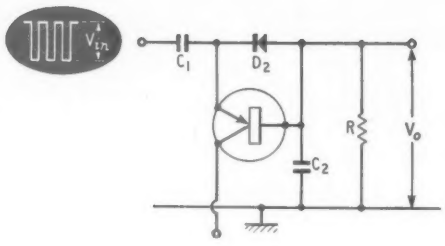
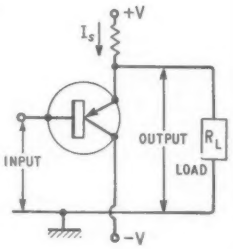


Fig. 5. Transistor pump circuit.



Above: Fig. 6. Simple linear frequency-voltage converter.



Right: Fig. 7. Emitter follower circuit.

C_2, and hence the increment of potential is exactly the same for each input pulse. A linear staircase results, the output being limited to values less negative than the collector supply voltage V_c. This circuit will produce only negative-going outputs; the corresponding circuit for positive outputs would use an n-p-n transistor.

One application of this circuit is to generate a voltage proportional to the frequency of a pulse train. A resistor R is placed across C_2 as in Fig. 6. Each input pulse puts a charge $V_{in}C_1$ into C_2, so that the average current into C_2 is $NV_{in}C_1$, where N is the pulse repetition frequency. When the circuit is in equilibrium the current supplied into C_2 must equal the current flowing out through R, which is V_o/R; where V_o is the output voltage; thus $V_o/R = NV_{in}C_1$, or $V_o = NRV_{in}C_1$. The output voltage is thus proportional to pulse repetition frequency: note that it is independent of the mark/space ratio of the pulses, and of the value of C_2 (if $C_2 >> C_1$). There will be a ripple component on the output of magnitude $V_{in}(C_1/C_2)$ volts peak-to-peak. The effect of the leakage current I_{co} flowing in the base of the transistor is to shift the zero of the output by a voltage $I_{co}R$; the variable nature of I_{co} will limit the maximum permissible value of this term, and hence of R.

Emitter-Squared Follower.—The emitter follower, Fig. 7, is a much used circuit where low output impedance is required. It is an unsymmetrical circuit, for although it can draw a substantial current (limited only by the signal source impedance and transistor dissipation) from the load R_L, it can drive *into* the load no more than the standing current I_s. This feature is particularly unfortunate when the circuit has to supply current pulses at a small mark/space ratio: the stage has to be designed with a large standing current which is needed for only part of the time. The drain on the power supply may be reduced and lower power transistors employed if the "emitter-squared follower" is used.

A d.c.-coupled version of this circuit feeding a capacitive load is shown in Fig. 8. Transistors V_1

and V_2 are connected in series and a standing current I_s ($I_s = I_{e1} \simeq I_{c2}$ under static conditions) flows through them and through R_c, the collector load of V_2. The circuit adjusts itself so that the voltage drop $I_s R_c$ coupled via R_1 and R_2 holds the base of V_1 slightly below earth potential (where it must be if V_1 is conducting).

On negative inputs to the base of V_2 the maximum current which can be drawn from the load is limited by R_c since V_2 must not bottom, and (as in the emitter follower) by the signal source impedance. On positive inputs some of the current I_s is diverted from V_2 into the load, with the result that the potential of V_2 collector falls and the base of V_1 is driven negative. V_1 is thus turned harder on and can supply into the load a current many times the standing current I_s. The principal limitation of the emitter follower is thus avoided.

The peak current into the load occurs when V_2 is cut off. It can be shown (see appendix) that the ratio of standing current to peak current into the load is approximately $1 + \frac{R_c}{R_2 + R_c} \cdot \frac{1}{1-\alpha}$. Since this is greatest for a large value of R_c whereas the peak current drawn *from* the load is greatest when R_c is zero, the design involves a compromise.

The variation with temperature of the working point of V_1 can be found by a simple approximate calculation as indicated in the appendix.

The base potential of V_2 must be chosen to allow adequate signal voltage excursions on the emitter and collector of V_2. It does not affect the standing current provided that there is no resistive load.

A circuit of this type has been used with great success as the output stage of an electronic integrator. It replaced an existing circuit using several transistors in parallel and drawing a relatively enormous current from the power supplies. Note that with this version of the circuit the power supplies must be reasonably stable, as the standing current depends rather critically on the supply voltages (see appendix).

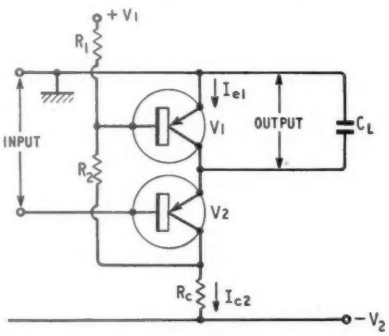


Fig. 8. Emitter-squared follower, d.c. coupled. Under static conditions $I_{c2} \simeq I_{e1}$.

Transistor Gating Circuit.—A transistor can be used as a simple and effective switch. Let us consider how this is done. If we connect up a transistor as in Fig. 9 we can define its emitter current I_e to be almost constant as V_1/R. The collector current I_c will be equal to $\alpha I_e + I_{co}$ and the base current I_b is thus $(1-\alpha)I_e - I_{co}$.

Reducing the magnitude of the collector voltage V_2 has little effect on I_c until the voltage between emitter and collector has fallen to a few millivolts; if further reduction is made in V_2 then I_c does begin to fall and the transistor is said to be bottomed. Since I_e is maintained constant the base current must increase, i.e., $I_b > (1-\alpha)\, I_e - I_{co}$.

This relationship is very important, because if we design any transistor circuit so that this inequality exists we know that the transistor is bottomed and hence that the voltage between emitter and collector is a few millivolts only.

Another important fact is that a transistor may be used back-to-front, that is, with the nominal emitter being used as a collector, and the collector as an emitter. Once again the voltage between emitter and collector is very small when the transistor is bottomed. The criterion for this is $I_b > (1-\alpha_r)I_e - I_{co}$ where α_r is the current gain of the transistor used back-to-front. Whereas α is typically 49/50, α_r may be as low as 2/3, so that more base current is needed to bottom the transistor in this case. Experience shows that adequate bottoming always occurs in the OC71 transistor when $I_b = 1 + I_e$ (I_b and I_e in mA). This will now be termed the bottoming criterion.

We can now see how the transistor can be used as a gate. In Fig. 10, I_b is made large enough to bottom the transistor so that point X, the emitter, will be almost at earth (collector) potential. In Fig. 11, X is again at earth potential although the transistor is operated back-to-front with current flowing from nominal collector to nominal emitter. Point X is even at earth potential in Fig. 12, where I_b has been made so large that I_e has reversed, although our previous argument does not help us since there are now in fact two emitters. Experiment shows, though, that as V_1 is reduced there is a

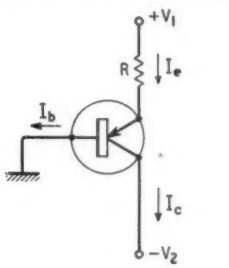


Fig. 9. Transistor with defined emitter current.

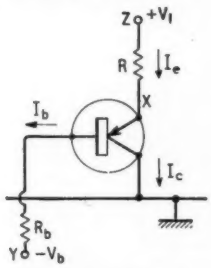


Fig. 10. Bottomed transistor, normal current flow.

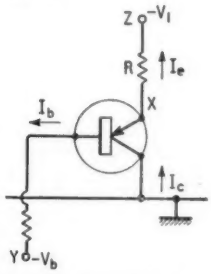


Fig. 11. Bottomed transistor, reversed current flow

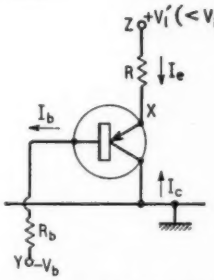


Fig. 12. As Fig. 10, but I_b is so large that I_e is reversed.

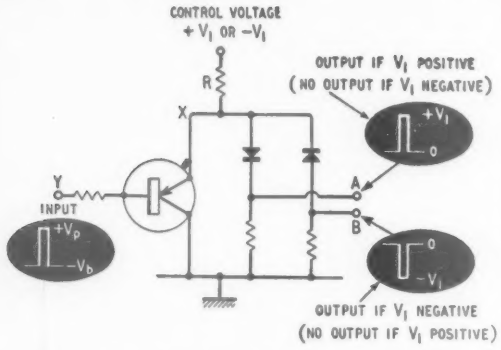


Fig. 13. Pulse routing equipment.

perfectly smooth transition from the Fig. 10 condition to the Fig. 12 condition and, when V_1 changes sign, to the Fig. 11 condition.

Point X is therefore always at earth potential when the bottoming criterion is satisfied. Since both emitter and collector are at earth potential either, or both, can be made to act as an emitter by taking the base a few tenths of a volt below earth. Thus whatever the sign or magnitude of V_1 the base is just below earth potential and the base current is $I_b \simeq V_b/R_b$.

Now for the open condition of the gate. If Point Y (Figs. 10, 11, 12) is taken from $-V_b$ to a value greater than V_1, both emitter and collector are cut off and point X takes up the potential V_1. (This is not exact since the reverse emitter leakage current I_{e1}‡ produces a drop $I_{e1}R$ across R; this incidentally sets an upper limit to R at any particular operating temperature, since I_{e1} like I_{co} varies rapidly with change of temperature. Typically $I_{e1} \simeq \frac{1}{8} I_{co}$.)

The action of the circuit is thus either to transmit the voltage V_1 from point Z to point X, or to short-circuit X to earth, depending on the potential at Y.

The transistor gate is a most versatile circuit; one rather unusual application is a two-way pulse routing circuit shown in Fig. 13.

Point Y is held normally at $-V_b$ so that the transistor its bottomed. Point X and both outputs are hence at earth potential. Input pulses are applied at Y and momentarily raise it to $+V_p$, where $+V_p > +V_1$. The transistor is thus cut off and X, for the duration of the pulse, assumes a potential approximately $+V_1$ or $-V_1$. If this is positive, an output appears at A, if negative, at B. The input pulse thus produces a pulse at A or B depending on the sign of the control voltage V_1.

A great virtue of this circuit is that since X is always within a few millivolts of earth when the transistor is bottomed, there is negligible change of potential there when V_1 changes sign. There is no risk therefore of step changes in the control potential waveform appearing at the output and being mistaken for genuine output pulses.

‡ Emitter leakage current when collector also back-biased.

APPENDIX

(Refer to Fig. 8)

Static Conditions

When there is no load current $I_{e1} \simeq I_{c2} = I_s$ (the standing current) ..... (1)

Since V_1 is conducting the junction of R_1 and R_2 is approximately at earth potential.

$$\text{Hence current in } R_1 = \frac{V_1}{R_1} \quad .. \quad .. \quad .. \quad (2)$$

$$\text{and in } R_2 = \frac{V_2 - I_{c2} R_e}{R_2 + R_e} \quad .. \quad .. \quad .. \quad (3)$$

Now base current in $V_1 \simeq (1-\alpha) I_{e1} - I_{co}$ .. (4)

and since the difference between currents in R_1 and R_2 equals the base current of V_1:

$$\frac{V_2 - I_{c2} R_e}{R_2 + R_e} - \frac{V_1}{R_1} = (1-\alpha) I_{e1} - I_{co} \quad .. \quad (5)$$

and writing from (1) $I_{c2} = I_{e1} = I_s$

$$I_s \left[(1-\alpha) + \frac{R_e}{R_2 + R_e} \right] = \frac{V_2}{R_2 + R_e} = \frac{V_1}{R_1} + I_{co} \quad (6)$$

Dynamic Conditions

The maximum current output occurs when the whole of I_{e1} is diverted into the load, i.e., when $I_{c2} = 0$. If under these conditions we write $I_{e1} = I_{pk}$ we have that: base current of $V_1 \simeq (1-\alpha) I_{pk} - I_{co}$ and repeating the step that gave us eqn. (5) (remembering $I_{c2} = 0$)

$$\frac{V_2}{R_2 + R_e} - \frac{V_1}{R_1} = (1-\alpha) I_{pk} - I_{co} \quad .. \quad (7)$$

$$\text{or} \quad I_{pk}(1-\alpha) = \frac{V_2}{R_2 + R_e} - \frac{V_1}{R_1} + I_{co} \quad (8)$$

Comparing (6) and (8), we obtain for the ratio of peak to standing current

$$\frac{I_{pk}}{I_s} = 1 + \frac{R_e}{R_2 + R_e} \cdot \frac{1}{1-\alpha} \quad .. \quad (9)$$

Eqns. (6) and (8) give the designer the necessary information about the variation of I_s and I_{pk} with I_{co}, and hence their variation with temperature.

International Instrument Show

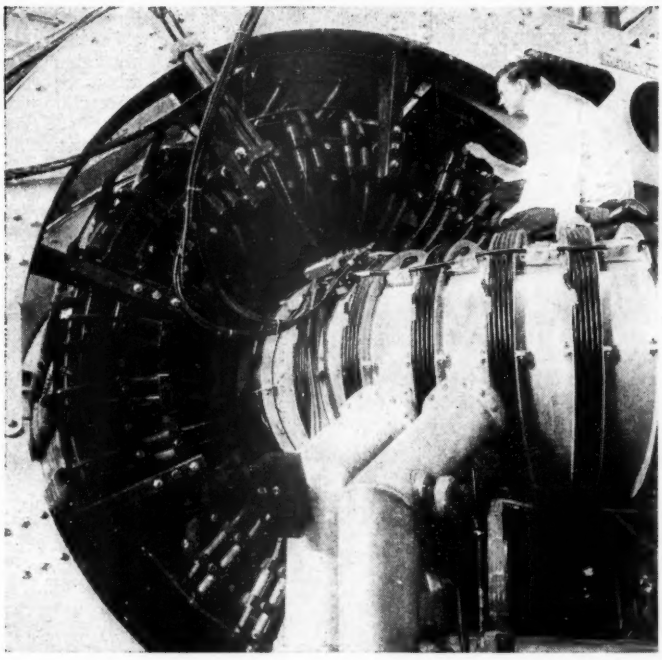
EQUIPMENT from 66 manufacturers in ten countries (see list below) is being exhibited at the 4th International Instrument Show to be held at Caxton Hall, Westminster, London, S.W.1, from March 24th to 29th. It will be opened each day at 10.30 and close at 6.30 except on Wednesday, 26th (9.0) and Saturday, 29th (12 noon).

In the past invitations have been sent to those who visited the previous year's show, but the organizers, B & K Laboratories, say this is no longer practicable because of the increased attendance last year. Applications for tickets should be made to the organizers at 57, Union Street, London, S.E.1 (Tel.: Hop 4567).

Austria: Ludwig Seibold.
Denmark: Bruel & Kjaer, Danbridge A/S, Disa Elektronik.
France: C. G. R., Jobin et Yvon.
W. Germany: Belzer-Werk, Dynacord, Deutsche Elektronik, Freiseke & Hoepfner, Hackethal, Intermetall, Rohde & Schwarz, Geo. Spinner, Wissenschaftlich Technische-Werkstatten.
Holland: Peekel Labs.
Italy: Lares S.R.L.
Sweden: Magnetic A.B. Sivers Lab.
Switzerland: Metrohm A.G., Muller-Barbieri, Vibrometer Inc.
U.K.: Advance Components, G. & E. Bradley, Racal, Union Radio Co.
U.S.A.: Advance Electronics Inc., Allen Bradley Co., Ampex Corp., Applied Physics Corp., Applied Science Corp., Audio Devices Inc., Bendix Aviation Corp., Brush Electronics Corp., Cascade Research Corp., DeMornay Bonardi, Electric Eye Equipment Co., Electrical Industries, Electronic Speciality Co., Electro-Measurements, Inc., Electronic Research Associates, El-Tronics Inc., General Precision Lab., Gertsch Products Inc., The Heath Co., Huggins Labs., International Rectifier Corp., Kay Electric Co., Krohn-Hite Instrument Co., MB Mfg. Co., Narda Corp., Neutronics Research Co., Norden Ketay, Northam Electronics, Nuclear-Chicago, Panoramic Radio Products, Polarad Electronics Corp., Polytechnic R & D Corp., Raytheon Mfg. Co., S.W. Industrial Electronics, Sperry Gyroscope Co., Sprague Electric Corp., Stoddart Aircraft Radio, Tape Cable Corp., Varian Associates, Vectron Inc.

Controlled Thermonuclear Power

RECENT RESULTS OF RESEARCH ON HIGH-TEMPERATURE PLASMAS



View of ZETA showing half of the spectacle-shaped transformer primary through which the aluminium ring containing the deuterium gas is threaded. The spaced stabilizing field coils round the ring are also visible.

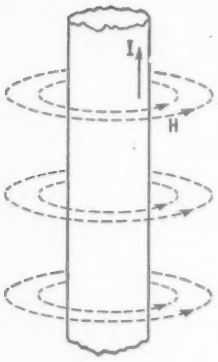
WHEN energy is released in a nuclear reaction, the total mass of the original reacting particles is more than the total mass of the products, the difference being equivalent to the energy produced. By collating data on the masses of nuclei, it can thus be shown that there are two types of nuclear reaction which release energy. One of these is the fission or splitting of nuclei of large atomic weight into two lighter nuclei, as used in atomic bombs or ordinary atomic piles. The other, as used in the hydrogen bomb, is the joining or fusion of nuclei of small atomic weight into heavier nuclei.

Fusion reactions have long been reproducible in the laboratory by the ordinary methods of nuclear bombardment. However, for obtaining an overall energy gain this method is quite inadequate, because nearly all the energy of the bombarding particles is lost in ionizing the target atoms. These losses could be avoided by using two colliding ionized beams; but in this case the highest particle densities which can be achieved are still far too low to give a usable release of power per unit volume.

Thermonuclear Reaction Conditions.—Sufficiently high particle densities can be readily obtained in a self-reacting system. The obvious way then to make the energy of the particles high enough for fusion reactions to occur, is to heat up the system until this energy is provided by the thermal (kinetic) energy of the particles, the reactions then being said to be thermonuclear. At the temperatures thus necessary, ionization is nearly complete, such a completely ionized gas being called a plasma. The required temperatures are in fact so high, at least tens of millions of degrees centigrade, that in practice only those reactions needing the lowest temperatures need be considered. The energy of the reacting nuclei can be smallest when the repulsion between their charges which must be overcome before any reaction can occur is also smallest. Thus the reactions to be considered are those between nuclei of low atomic number. The easiest reactions to bring about are then found to be those involving the heavy isotopes of hydrogen, i.e., deuterium and tritium. The temperature required to produce a reaction between deuterium and tritium is about one half of that required for deuterium alone; but this advantage is offset by the scarcity of tritium.

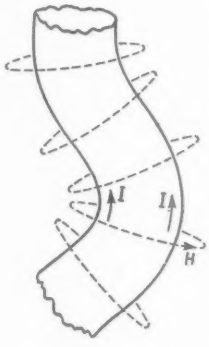
The rate at which individual thermonuclear reactions occur increases as the temperature is increased, so that the total thermonuclear energy produced also increases. Energy is radiated from plasmas producing thermonuclear energy mainly in the form of bremsstrahlung, i.e., X-rays produced when free electrons are deflected by positive ions. This radiated energy also increases with temperature, but at a slower rate than the total thermonuclear energy produced. Thus, at a sufficiently high temperature (at least 5×10^7 degrees centigrade in the reactions of interest) the thermonuclear energy produced will equal the energy radiated. Assuming no energy is conducted away this then is the lowest temperature at which a self-sustaining reaction is possible. At such temperatures usable amounts of energy per unit volume are released at particle densities corresponding to quite low pressures of the order of 0.1 mm of mercury or less. These pressures are, however, greater than those in ordinary gas discharges.

Reasons for Confining the Gas.—The energy conducted away is proportional to the surface area,



Above: Fig. 1. Pinch effect. The field H forces inwards currents such as I in the outer part of the discharge.

Below: Fig. 2. Kink instability. The field is greater on the inside of the bend than on the outside, so that the dissimilar forces on the currents I tend to make the bend larger.



whereas the thermonuclear energy produced is proportional to the volume. Thus the conduction can be relatively reduced by increasing the size of the system. At the pressures and temperatures we have discussed, however, it will still far exceed the radiated energy for any practical size of system. Thus, to operate at the lowest possible temperature, conduction must be prevented by separating the reacting gas from the walls of the container by means of a suitable force. Moreover, at the low plasma densities used, the average distance of about 50,000 km between collisions is so long, that unless such a containing force is used, the particles will escape from the reacting region. This long distance between collisions also means a long average time interval (about ten seconds) between energy-producing collisions. Thus to ensure that the fraction of nuclei which take part in thermonuclear reactions is large enough to give a net energy gain, the gas must be confined for a time of the order of a second.

Fruitless Confinement Methods.—Gravitational attraction is only possible as a means of confinement in systems of stellar mass. However, at these temperatures and densities the ionized gas is about one hundred times as good a conductor as copper, and this suggests that electric or magnetic fields could be used to confine it. Electric fields cannot be used both for theoretical and practical reasons. Theoretically, Earnshaw's electrostatic theorem shows that no stable equilibrium position would be possible, and also, a confining field for the electrons would tend to disperse the positive ions. Practically, the fields required, of the order of 10^7 volts/cm, are much higher than the highest which can be produced.

Pinch Effect.—Confinement by means of magnetic fields is feasible. Fields of about 10^5 gauss are required, and these can be produced in the plasma volume by currents of the order of 10^7 amperes. The simplest way to produce a field in the right direction is to pass a current through the gas, when the direction of the field may be determined by the corkscrew rule. The force on currents flowing through the outer part of the discharge is then inwards (by Fleming's Left Hand Rule) as may be seen from Fig. 1, this being known as the pinch effect. By considering the discharge as being composed of a number of parallel currents, the pinch effect may also be regarded as being due to the attraction between parallel currents in the same direction; this attraction being caused by similar interaction with the magnetic fields produced by the currents. Such high currents, possibly together with adiabatic compression produced by the pinch effect or otherwise, will in any case have to be used to heat the gas sufficiently. Thus this method of confinement is both simple and convenient.

Unfortunately, the pinch is unstable, any small displacement at right angles to its length increasing until the plasma column is disrupted. This is because the magnetic field at the concave portion of such a kink is increased and that at the convex portion is decreased, as shown in Fig. 2. Thus the inwards attraction is increased at the concave portion and decreased at the convex, thus producing a net resultant force tending to increase the kink. The increase in the size of a kink is in fact extremely rapid, and the plasma column becomes disrupted in less than a few microseconds.

Avoiding Kink Instabilities.—Two methods of counteracting this instability have recently been reported. One of these is simply to use a metal conducting container for the gas. If the plasma then moves from a central position its magnetic field induces eddy currents in the container walls in such a direction that by Lenz' law their associated magnetic field produces a force on the plasma back towards its central position.

The other stabilizing method is to apply a magnetic field along the discharge. This field becomes almost completely trapped in the discharge as it contracts. This is because, owing to the very high conductivity of the plasma, any movement of the field through it would induce such high currents that their associated fields would cancel out the field movement through the plasma. Similar effects are observed with superconductors. Any kinking of the discharge then distorts the trapped field so that the kinking is opposed, as would also happen if the field lines were replaced by their usual stretched elastic band analogues.

A consideration of the paths of the individual charged particles also shows how a magnetic field inhibits motion at right angles to it. In this case, the paths become circles with radii inversely proportional to the field strength. Because of this coiling up of the motion of the particles, the mean distance between collisions for movement at right angles to the field becomes roughly equal to the radius of the circular motion. The mean distance between collisions may thus be considerably decreased, this making the rate of diffusion much less.

No confinement of the plasma length is provided by the pinch effect. The obvious way to avoid losses at its ends is then to close it upon itself to form a ring. The heating or pinching current in the discharge must then be obtained by induction, such as simply by making the whole ring the single-turn secondary of a pulse transformer. The high currents required can be produced by discharging a condenser through the primary. The metal container must be subdivided into a number of insu-

lated sections to avoid short circuiting the current input to the discharge.

Most of the published experiments have followed this general line of attack, though other methods are also being developed in America. In some cases linear discharges have been used, and also stabilization solely by means of a longitudinal field. Temperatures of several million degrees centigrade have been generally obtained.

ZETA.—The longest containment time which has been achieved is 5msec in ZETA at Harwell. Here temperatures up to 5×10^6 degrees centigrade have been reached in deuterium gas at pressures of from 10^{-4} to 10^{-3}mm of mercury. The containment time and temperature are at present only limited by the available power input which it is hoped to increase shortly.

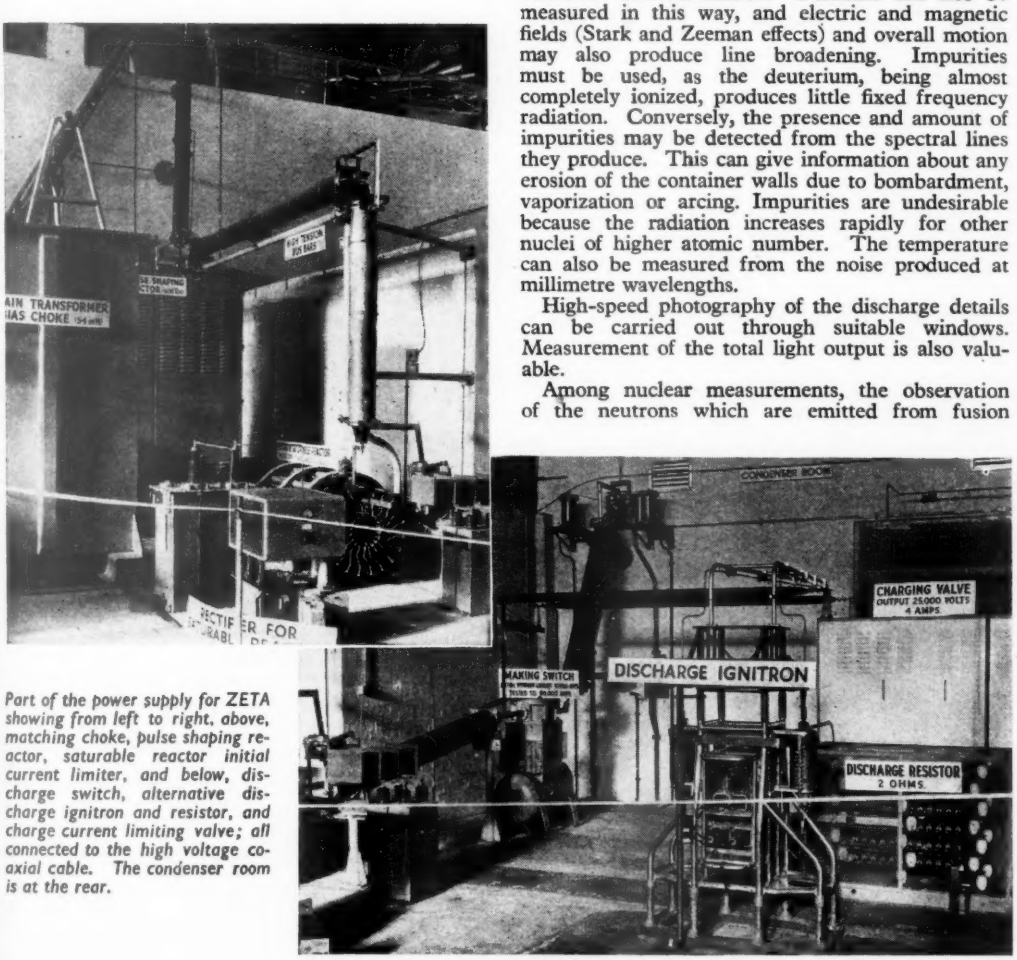
ZETA uses a ring discharge container of one metre bore and three metres mean diameter. This threads the two halves of the spectacle-shaped transformer primary through which 1600μF at 25kV are discharged to give up to 2×10^5 amperes in the deuterium gas "secondary." This gas is initially weakly ionized by a discharge at 4 Mc/s using about 1kW of power. The stabilizing field used is quite small, about 200 gauss, though this is rather less than that used in other experiments. It is produced by coils wound round the ring. The container is made of one inch thick aluminium, subdivided into 48 insulated sections.

Plasma Diagnostics.—Owing to the use of a mixture of ions of opposite charges and different masses (electrons and nuclei), in the simultaneous presence of magnetic and electric fields in various directions, under conditions where radiative and nuclear effects are important, and with the possibility of oscillations, transients and turbulences, very complicated processes can occur for which the theory is often only approximate.

A wide variety of measuring techniques are therefore used. Taking non-electronic methods first, there are the spectroscopic techniques used in studying the stars modified to deal with the higher temperatures. An important example of these is, of course, the measurement of temperature from the broadening of line spectra produced by the Doppler effect for thermal motion. Densities can also be measured in this way, and electric and magnetic fields (Stark and Zeeman effects) and overall motion may also produce line broadening. Impurities must be used, as the deuterium, being almost completely ionized, produces little fixed frequency radiation. Conversely, the presence and amount of impurities may be detected from the spectral lines they produce. This can give information about any erosion of the container walls due to bombardment, vaporization or arcing. Impurities are undesirable because the radiation increases rapidly for other nuclei of higher atomic number. The temperature can also be measured from the noise produced at millimetre wavelengths.

High-speed photography of the discharge details can be carried out through suitable windows. Measurement of the total light output is also valuable.

Among nuclear measurements, the observation of the neutrons which are emitted from fusion



Part of the power supply for ZETA showing from left to right, above, matching choke, pulse shaping reactor, saturable reactor initial current limiter, and below, discharge switch, alternative discharge ignitron and resistor, and charge current limiting valve; all connected to the high voltage coaxial cable. The condenser room is at the rear.

reactions can give information on the temperature, density of spatial distribution of the plasma. Such neutrons should be detectable at much lower temperatures than those necessary to give a power gain from thermonuclear reactions. Unfortunately, various types of electromagnetic disturbance can also accelerate the deuterons to produce neutrons, and it is difficult to distinguish with certainty between these two effects. High energy X-rays are also produced in the plasma.

Electric and Magnetic Measurements.—A simple measurement of voltage and current in the pinch can be used to determine its radius. Neglecting resistive effects we have $V=d/dt\ (LI)=LdI/dt+IdL/dt$, where L is the inductance and t the time. Inserting measured values for V, I and dI/dt then gives an equation which can be solved for L as a function of time. L is also a known function of the pinch dimensions.

Magnetic fields can be measured from the currents they induce in coils both in and outside the discharge. When such fields are trapped in the plasma this measurement also determines its motion. Electric fields and ionization may be measured from the current between two electrodes at different potentials inserted in the gas (Langmuir probe). The use of probes in the plasma is limited by the need to avoid disturbances and losses.

By observing the transmission or reflection of millimetre waves in the plasma, data on its refractive index may be obtained. Since this is equal to $[1-8.1\times10^{7}\ (n/f^{2})]^{\frac{1}{2}}$ where n is the number of electrons per cubic centimetre and f the frequency in c/s, this also gives a measure of the electron density.

Energy Extraction.—Ideas on this are of course entirely theoretical at present. The obvious method is to extract heat from the discharge as it eventually reaches the container walls.

The emitted neutrons could possibly be used to control or initiate a modified fission reactor. Their energy could be recovered by absorbing them in lithium six. The resulting nuclear reaction, besides giving off energy, also produces tritium which could be used in the discharge.

An exciting possibility is to use the magnetic field arising from the plasma to induce current directly in an external circuit.

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I.T.A. ST. HILARY STATION: DETAILS OF THE PYE TRANSMITTER

PROGRAMME transmissions from the new I.T.A. station at St. Hilary, near Cardiff, began on January 14th. Only three months had been needed for the installation and testing of the Pye transmitting equipment.

The 20-kW (200 kW e.r.p.) vision and 5-kW sound transmitters have been given a similar design, except for their final output stages, to reduce the number of spare valves and components required. Each consists of a crystal drive, stable in frequency to better than 1 part in 10^{7}, whose 3-watt output is applied to a frequency multiplying unit to give the carrier frequency. The 30-watt output from this unit is amplified to levels of 500 watts and 5kW in the next two stages.

In the vision transmitter the picture modulation is applied to the grids of the 5-kW amplifier valves. The modulated signal output drives the cathodes of the final vision output amplifier, which uses two 4W,20000A tetrodes in a grounded-grid double-cavity resonant circuit. The sound transmitter is anode and screen modulated in the final output stage which uses only a single 4W,20000A valve.

Coaxial cable is used throughout the additional G.P.O. vision links which integrate the new station into the whole I.T.A. network. In most cases, after double frequency changing, signals are transmitted on a carrier frequency of 1.056 Mc/s in the band 0.5 to 4.0 Mc/s.

Console control equipment for the I.T.A. St. Hilary station. Also shown facing the operator is the 20-kW vision transmitter.

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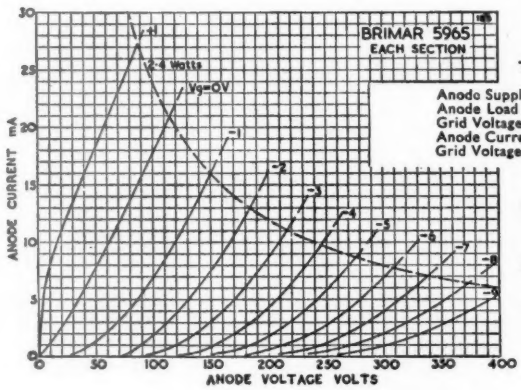

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† *Approximate value of grid voltage with grid current adjusted for approximately 140μA.*

‡ *The grid voltage required to produce 150μA in one section normally will not differ by more than 1.5 volts from the grid voltage required to produce 150μA in the other section with an anode supply voltage of 150 volts and an anode load resistor of 7,200 ohms.*

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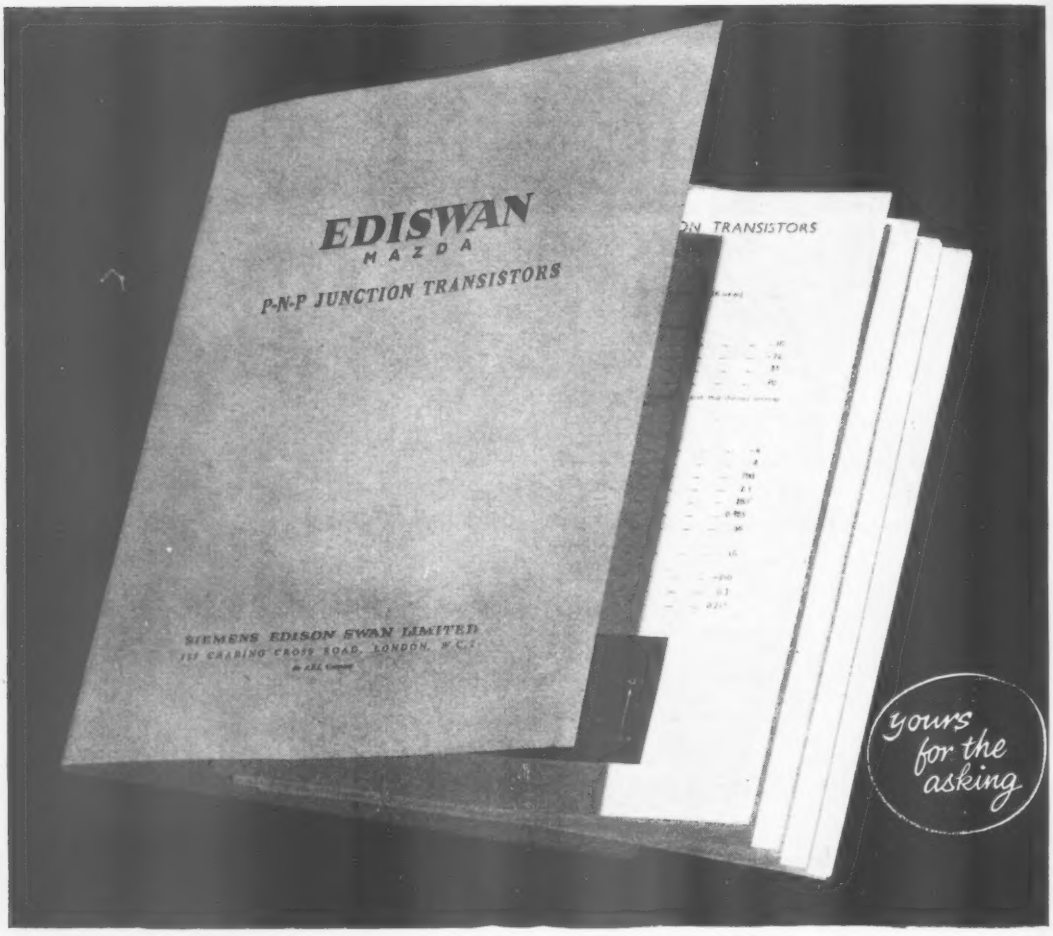

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WAVE MECHANICS

Different Laws for a Small-Scale Universe

By "CATHODE RAY"

LAST month we considered the two basic ingredients of the universe: mass and energy. They seem so obviously different in kind—one being the most material thing about matter, and the other somewhat abstract—that it was surprising to find that each can be converted into the other at a fixed rate of exchange. Still, this didn't necessarily mean that they had much in common, any more than pound notes have much in common with 18 days' tour of the Tyrol, apart from being exchangeable at a certain rate.

It had been known for a long time that matter was made up of atoms, which come in certain fixed sizes; and even though atoms were later found to be made of electrons, protons and neutrons, these were particles of certain definite sizes. Energy, on the other hand, seemed quite different—something that could be handed out in any quantity, large or small. It could be radiated from place to place as light, heat, radio, X-rays, etc., and although as great a scientist as Newton had held some queer notion about light consisting of streams of particles, that was hundreds of years ago and had long since been thrown overboard because of the overwhelming evidence that all these kinds of radiation were electromagnetic waves, which of course streamed forth continuously and were capable of having any amplitude.

Packets of Energy

But with the dawning of the twentieth century, evidence was accumulating which just didn't fit these apparently soundly established principles. So Planck put forward his quantum theory that energy is not radiated as a continuous flow but in "packets" or quanta, the sizes of which are directly proportional to the frequency of the radiation and are not related at all to its intensity. This theory seemed (to say the least) unlikely, but has become more and more firmly established as it has been found to agree with more and more experimental facts. You may remember that one of the things it was invented to explain was that high-frequency radiation, however small in amount, is able to ring the bell of atomic "Try Your Strength" machines, where unlimited quantities of low-frequency radiation completely fail.

The thing is expressed a little more scientifically in Planck's equation which we noted last month:

$$E = hf$$

in which h is Planck's constant (6.6×10^{-34} joules per c/s), and E is the amount of energy in each quantum of radiation at frequency f c/s. Yellow light has a frequency of about 5×10^{14} c/s, so its energy is radiated in quanta of $6.6 \times 10^{-34} \times 5 \times 10^{14} = 3.3 \times 10^{-19}$ joules. Now a joule is a watt-second; that is to say, the amount of energy equal to a power of one watt working for one second. It can also be called a volt-amp-second, or (since a current of one amp flowing for one second carries a charge of one coulomb) a volt-coulomb. Since the energy of a single quantum of even high-frequency radiation is very small, it is more conveniently expressed in much smaller units. An electron carries a charge of only 1.6×10^{-19} coulombs, so a volt-electron or electron-volt (eV) is a convenient unit for small amounts of energy. Our quantum of yellow light, for instance, is $3.3 \times 10^{-19} / (1.6 \times 10^{-19}) = 2$eV. This is equal to the amount of kinetic energy acquired by an electron in "falling" through a difference of potential of 2V, say between cathode and anode of a diode. It is analogous to the 2 ft-lbs of k.e. acquired by a 1 lb weight in falling 2 ft.

Contrasts in Quanta

In the same simple way we can calculate that each quantum of energy emitted from the Crystal Palace television station with all the majesty of its 200 kW e.r.p. is rather less than one fifth of one electron-*micro*volt—like a grain of grit to the dog-carrying sputnik radiated by the dimmest candle. At the other extreme come quanta of 10,000 eV upwards from X-rays, and of many millions of eV in cosmic rays. It is just as well that they are so thin on the ground!

The difficulty is to reconcile this sort of thing with all the evidence to show that radiation consists of waves. As regards radio, no one seems even to attempt to do so. The wave concept still reigns supreme. The reason presumably is that the radio-wave quanta are so insignificant individually and so numerous that there is no more inducement to consider them than there is to take account of each separate molecule when pouring out the tea. One is more likely to notice that by blowing on tea one can form it into the most convincing-looking miniature waves! X-ray quanta, on the other hand, are like the lumps of sugar—much fewer, but each capable of creating quite a noticeable splash. So it is usual to consider this high-frequency radiation as quanta rather than waves.

To introduce the subject of loudness in last November's issue, I drew what seems to have been accepted without question as a reasonable representation of an air wave by varying pencil-shading along a strip of paper. Although the general impression at a glance was that the depth of shading varied continuously in a wavelike manner, looking at it through a magnifying glass would reveal that this impression was produced by the varying density of grains of graphite. One could put it this way: that the intensity of air-wave pressure at any point was represented by the probability of finding a grain of graphite at that point. The physicists' statement that radiation consists of "waves of probability" may sound very baffling until we realize that the same thing applies to this pencilled picture of a wave.

So the picture is a help. But if we're not careful we shall be misled by it. If we follow it up too closely we'll visualize a radiator sending out a cloud of photons (as these quantum-sized packets of energy are called) gradually increasing in density as the positive peak of what we otherwise describe as the wave is reached—and then we will be stuck to

describe what happens during the negative half-cycle, for there are no negative photons. Even if there were they wouldn't correctly represent a negative half-cycle. The mistake (for which I with my pencilled airwave analogy am chiefly to blame) is in supposing that the density of photons represents the *instantaneous* value of the wave, whereas it represents its power intensity or mean square value. The frequency of the radiation is not conveyed by the photon density being broken up into a wavelike distribution, but by the size of their quanta. If each one is about 2eV and some of them reach our eyes we say "Ha! there is a yellow light!" (or words to that effect) and, performing optical tests on them, we find they behave in many respects as if they were waves of frequency 5×10^{14} c/s (=500 MMc/s) and length 6×10^{-5} cm. That being so, it is allowable and convenient to make use of wave mathematics so far as applicable. At the low-frequency end—and that includes all our radio, even microwaves—it is applicable practically all the way. They are therefore commonly called waves, even by people who know differently.

Travelling Through Space

While this makes it hard for us to accept the particle idea, we must admit that it clears up at least one major difficulty—how the supposed waves cross empty space, since it has been demonstrated that there isn't even an ether to carry them. Particles, on the other hand, travel most easily through space that is completely empty, which is also a feature of radio "waves" and light.

Almost as soon as people had been driven to the conclusion that these "waves" of radiation were, in spite of all appearances to the contrary, streams of particles, another line of research was demonstrating that streams of particles (to wit, electrons) behaved in some respects as waves! Although such a thing is singularly difficult to visualize, there is a certain rough logic in it. The rigid distinction between mass and energy, each with its separate Law of Conservation, had already been broken down, yielding a single Law of Conservation of Mass-cum-Energy. So it is appropriate that the rigid distinction between waves and particles should break down into something which seems to be both at once. But just as the queer tricks that things get up to in Einstein's relativity are only significant at extremely high speeds, the particle aspect of radiation is only significant at very high frequencies and the wave aspect of particles is only significant in very small sizes. So although theoretically the traditional "hail of bullets" from the ruthless foe behaves to some extent like a beam of light, the extent is negligible. When one gets down to the electron size, however, the situation is quite different. So different that the behaviour of electrons cannot be explained or described at all fully on the assumption that they are just very small particles, but only on the assumption of a strongly wave-like nature.

The working out of this theory, which has been very successful in elucidating the behaviour of electrons, especially as components of atoms, is known as wave mechanics; and the worker-out-in-chief was Schrödinger. The name "wave mechanics" is likely to have a discouraging sound, bringing together as it does two ideas which do not seem to make much sense in combination. But then in atomic physics one must be prepared to abandon so-called common sense, which is no more than the really rather stupid mentality of the Jovian giant who assumed that the bricks of which earth houses are built are themselves tiny houses. It is equally stupid of us to expect that the ultimate "bricks" of the material objects we can see are similar in nature only smaller. It is rather presumptuous to expect to be able to understand their real nature at all. But wave mechanics has enabled people to get a much better insight than the "tiny billiards ball" ideas of the past.

This is where we take up again the unsolved puzzle of last month—the atom, which we know consists of a number of electrons around a nucleus. Because these are oppositely charged, there is an electric force tending to draw the electrons towards the nucleus. This sort of situation is familiar to us on our earth, where there is a gravitational force tending to draw all other bodies to it. We know that the electrons do not in fact ever fall right down to the nucleus, so something must keep them up. Their obvious counterpart would seem to be the moon, which stays up by revolving around the earth at a suitable rate. But whereas a moon's orbit could be at any radius, provided the rate were suitable, it is known that there are only a limited number of possible "orbits" for electrons. And anyway, why don't any ever fall? Even sputniks do so in time, and millions of meteors fall to the earth—or at least its atmosphere—every day.

Calculated Probabilities

The answer is given by wave mechanics. Unfortunately it is essentially mathematical, so it is not at all easy to visualize even in roughest outline, but it goes something like this:

The ordinary laws of mechanics, which apply very well to moons and sputniks around the earth, prove inadequate when the scale of the system is as small as electrons around a nucleus. In both systems there are satellites moving in a field of force; the moon moves in a gravitational field and the electron in an electric field. Because of the small scale of the electron, the equations of mechanics relating to its motion around the nucleus are modified in a way closely similar to the equations of the wave theory of light relating to a beam in a medium of varying refractive index (such as the air above a hot radiator, which bends the light rays so that the air is seen to shimmer). We have already noted that the intensity of light anywhere means the probability of finding a photon there, but that it can nevertheless for convenience be reckoned as the strength of an imaginary ether wave vibration. Correspondingly in wave mechanics, the probability of finding a particle anywhere can be reckoned in terms of imaginary wave vibrations of another kind. It turns out that this modification makes no significant difference unless the particles are very small; when they are as small as electrons the particle-likeness gives place very considerably to wave-likeness.

Even if I were capable of expounding the mathematics of wave mechanics, this would not be the place to do it. There are plenty of books. But in passing I suspect that there is quite a close analogy between the nature of electrons and (a) the behaviour of radio signals in the ionosphere, and (b) the distor-

tion of pulses in line transmission, discussed by Thomas Roddam in last December's issue.

The above summary of wave mechanics is probably as clear as mud, but I hope that one shining pearl can be salved from it—the bit about the probability of finding an electron. For lack of anything better we have been talking in terms of the now outmoded electron *orbits* around the atomic nucleus. There is never any chill feeling of doubt about the precise position of the moon at any moment; if we do not personally know, we are quite sure the astronomers do. Even sputniks can be plotted with considerable accuracy. But to extend this idea of precise position to bodies as small as electrons has been found to be illusory. The best we can do is write an equation or plot a curve showing the relative probability of a body being at various points in space. With all except very small bodies the indication is a virtual certainty for one position and a negligible probability everywhere else. But an electron can only be pictured as a haze of probability around the nucleus. The simplest atom, of course, is a hydrogen atom, with only one electron; and Fig. 1 is a curve showing the probability against radius from the centre of the atom. This should not be taken to mean that the electron is actually at a certain constant radius which we don't happen to know exactly; it means that the electron is on the move all the time and at any given moment it could be anywhere, but that the chance of its being at any particular distance from the nucleus is proportional to the height of the curve in Fig. 1 at the point representing that distance. The curve shows that at distances greater than two hundred-millionths of a centimetre (=2 Ångström or 2Å) the chance is small.

As Fig. 1 shows, the most probable radius is 0.53Å. The interesting thing about this is that according to the older (orbit) theory, due to Bohr, the radius of the orbit nearest the nucleus (seat No. 1 in our atomic restaurant, or the lowest energy level) was 0.53Å.

Elusive Electron

This substitution of a probability haze for a clearly defined orbit seems to be a retrograde step, and one may well ask if it is really necessary. Why shouldn't mathematicians who are clever enough to think up such a system as wave mechanics be able to specify the precise movements of their satellite, like the astronomers can do standing on their heads? The answer comes, quite definitely and relentlessly, that neither in theory nor practice can anyone ever tell exactly where any electron (having a fixed energy) is. Accustomed as we are to scientists having the answer to really difficult questions at once and impossible ones at short notice, this unanimous ignorance concerning what one would have thought was routine stuff is astounding. It has at least been dignified by a special name—Heisenberg's Uncertainty Principle. Naturally we hasten to make all sorts of bright suggestions as to how an electron could be located, and the scientists explain with as much patience as they can that all these methods involve some sort of observation, and the observation is bound to affect the momentum (and hence the energy) or position or both, to an extent that is decisive when the thing observed is as small as an electron. One is apt to assume, for example, that just looking at a thing leaves the thing unaffected; but it is only because the thing is emitting quanta of energy that it is visible, and such emission alters the state of the emitter even before it reaches the eye of the observer.

But to get back to where we were with wave mechanics before that interruption. When the basic equation (the Schrödinger equation) is applied to the particular case of an electron in the field of force around its nucleus, the result is a general equation with only a limited number of physically possible solutions. The celebrated Ohm's-law equation, I=E/R, is an example of a general equation, in which theoretically E and R—and therefore I—can be absolutely any quantities. But if the only resistors in the world were identical carbon blocks and the only sources of e.m.f. were lead/acid cells, then the current I could in practice only have certain values, functions of whole numbers (the numbers of blocks and cells in series and parallel arrangements). And so it is with the Schrödinger equation applied to atoms. The total energy of an electron as part of an atom is made up of potential energy, which is less the nearer the nucleus it is (compare a weight at different heights above ground) and of kinetic energy, which is greater the nearer the nucleus it is, because it has to move faster. This increase in k.e. only half offsets the loss in p.e., so the total is less at short radii. The Schrödinger solutions correspond to certain isolated energy levels, each with its haze of probability differently spaced around the nucleus.

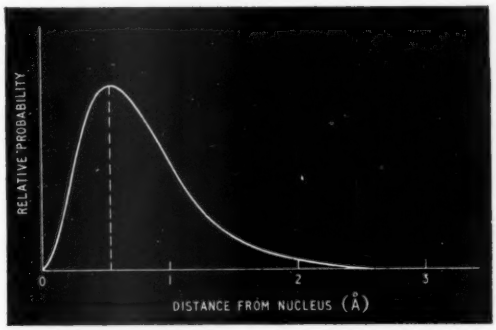


Fig 1. Relative probability of finding an electron at different distances from the centre of a hydrogen atom, when the electron is at its basic or lowest energy level.

Because Fig. 1 applies to radii in any direction from the nucleus, the haze represented by it must be spherical in shape. That seems so natural that we may be surprised to learn that most of the other hazes, corresponding to higher energy levels, are not spherical but stick out sideways like the solid polar diagrams of directional aerials. Their forms are determined by the Schrödinger whole numbers. These come in sets of three, each set representing a possible electron haze or energy level. In each of these there can actually be two electrons. But this is not really a breach of the Pauli Exclusion Principle (the dignified name for the no-petting rule which decrees that only one person shall occupy any restaurant seat at any one time). Part of the k.e. of the atomic electrons is due to their spinning around themselves as well as around the nucleus, as the earth spins on its axis while revolving around the sun. And because the two electrons that both answer to the same three-figure code specification spin in

opposite directions, a fourth figure can be added to the code to indicate direction of spin. So although the seats are in pairs, each seat (distinguished from all others in that restaurant by its own four-figure code) will take only one electron.

Coded Specification

The modified picture of an atom that emerges from wave mechanics thus consists as before of the nucleus surrounded by a certain number of electrons, depending on what the atom is an atom of, but instead of each electron being locatable in an orbit of definite radius it is marked by a haze, the density of which at any point represents the probability of its being there. Although this seems vague, the size, shape, position and density-pattern of the haze is quite precisely defined by a four-figure code sign. These code signs are confined to a quite moderate range of whole-number combinations, specifying the individual seats in any of our atomic restaurants. Every electron in an atom must occupy a separate seat (Pauli Exclusion Principle). The seats occur in groups, corresponding to the restaurant tables; those in a given group are distinguished by having the same first figure in their code signs. Most of them are divided into sub-groups, indicated by the second figure. Each seat is a certain energy level, beginning with No. 1 (code 1-0-0-a or b) nearest the nucleus with the lowest energy. An electron can be kicked up into a vacant higher-energy seat, if a sufficient quantum of energy to do it comes in from somewhere. Such an electron tends, however, to drop back from this elevated position, and in so doing gives up a quantum of energy equal to the difference between the energy values of the two seats concerned.

Exchanges of this kind are constantly going on, and are of especial interest to readers of *Wireless World*. For instance, the atoms in the fluorescent screen of a TV tube are supplied with energy by the high-speed electrons shot at them from the gun; their own electrons are pushed thereby into higher energy levels, and quickly drop back again. The kind of atoms put there by the manufacturer were chosen by him so that the differences in energy levels were such that the frequencies of the radiation, as calculated by Planck's equation, are distributed broadly between 400 and 800 megamegacycles per second, these being the frequencies that make up white light.

This is only one of many examples of these electronic energy exchanges, which are the subject we have been pressing on towards all the time. Next month we go into more detail about how they happen and the results produced.

LETTERS TO THE EDITOR

The Editor does not necessarily endorse the opinions expressed by his correspondents

The Clark Cell

I OPENED W.W. in some trepidation this morning, fearing to read that both "Free Grid" and "Diallist" had been asked to resign for stating that the e.m.f. of the Clark cell was 1.1 volts. Kaye and Laby, whose physical and chemical constants have supported my left elbow since 1919, say that it is 1.433 volts at 15°C.

As a very junior egghead I used to buy my bell-wire and cables in coils of 110 yards and I used to believe that if one put 110 volts in at one end, 100 volts came out at the other; not for long. Anyhow 110 volts made a nice "long" volt on the analogy of a "long" calorie.

Little Hadham, Herts. HUMPHREY DENHAM.

Tape Speeds

IN connection with the recent discussion of the tape speeds I would like to supply the following information.

The Deutsche Normenausschuss (DNA)—German Standards Committee—divides tape recording equipment into different "classes" according to the tape speed. Its standard, DIN 45 511*, distinguishes between five classes which correspond to the following speeds:

Class		76	38	19	9	5
Tape speed	(cm/sec)	76.2	38.1	19.05	9.53	<9.53
	(in/sec)	30	15	7.5	3.75	—

For class 5 the speeds of 9.53/2, 9.53/4, 9.53/8, etc., cm/sec are preferred. It can be seen that the class number immediately gives an indication of the tape speed. Without resorting to new units this classification seems to be a convenient way of describing a tape recording system. The same standard (DIN 45 511) also covers the electrical properties of the different classes, e.g., frequency response, input and output voltages and impedances, signal-to-noise ratio, etc.

P. E. BECKMANN,
University College of North Staffordshire.
Keele, Staffs.

* Published by Beuth Verlag, Cologne, Germany.

I WAS interested to see your editorial comment and Mr. Davies' letter concerning tape speeds in the February issue. It is indeed praiseworthy that an international basic speed should be agreed upon, and the round figure of 30 is convenient for us. It is unfortunate that fractions occur when it is divided by a factor (standardized as a multiple of 2) to give the slower speeds.

But why divide? For example, $1\frac{7}{8}$ could be written as 30/16, which is not only easy to write but shows the relation to the basic speed, and makes it very easy to calculate the playing time, since with 150 feet of tape the playing time in minutes is equal to the above-mentioned factor.

Example: Speed 30/16 in/sec, length 600ft.

$$\text{Playing time} = 16 \times \frac{600}{150} = 16 \times 4 = 64 \text{ minutes.}$$

I hope, if this or a similar notation is adopted, that the whole fraction is used, and not the factor alone, which is inversely proportional to speed.

Birmingham, 13. D. L. CLAY.

AS a very early wireless man I recall visiting Copenhagen in 1910 and meeting Dr. Poulsen, of arc fame. He demonstrated his Telegraphone to me and I always associate tape recording with this brilliant man. For your proposed unit Poulsen is probably too long, but "Teleg" might do. What about "Dane"?

London, W.4. H. ANTHONY HANKEY.

FOLLOWING "Free Grid's" remarks and Mr. H. Davies' letter in your January and February issues respectively, you invite suggestions for an appropriate

name for the unit of tape speed. I would like to offer one.

Before doing so, may I comment on the suggested origin of the multiple of 11 prevailing in power-supply voltages and referred to by "Diallist" and "Free Grid." I have always understood, admittedly in a vague sort of way, that it was based on a tentative maximum regulation figure of 10 per cent. To be more explicit, if you generate at 110 V and assume a 10 per cent drop under the worst conditions, i.e., at the end of a long, not overloaded line, you would at least have a terminal voltage of 100 V, a nice round figure.

I, like Mr. Davies, do not know why 77 cm/sec precisely was adopted as the standard tape speed in Germany but again, in a rather nebulous fashion, I understood it was for the following sound reason. The German Magnetophon spool was designed to hold a 1,000-metre length of tape, a good all-round figure. At a speed of 77 cm/sec the playing time for a full reel is nearly 22 minutes; time for a 20-minute programme plus an 8 per cent margin.

I think it rather a pity that you should turn down "Free Grid's" suggestion of the Stille as a unit of tape speed. Its singular aptness is appreciated only when one grasps the significance of his proposal that 100 Stille should correspond to $1\frac{7}{8}$ in/sec. On this basis, one Stille would presumably be 0.01875 in/sec, a tape speed at which you could reasonably say that one Stille was a little stiller than two Stille. If, as I suspect, "Free Grid" intends the Stille to be used not as a factor but as an exponent like the decibel, i.e., tape speed $= 1\frac{7}{8} \times 2$ to the power $(-100 + \text{St.})$ in/sec, then one Stille would be a little stiller still.

Seriously, why not "Poulsen" as a suitable name for the unit since, if anyone is entitled to be called the father of magnetic recording, surely it is Valdamar Poulsen? B.S. 1991 already gives two meanings for P. Who are we to boggle at a third?

Slough, Bucks. H. G. M. SPRATT.

F.M. Discriminator Bandwidth

I WOULD like to point out that a further advantage of a wide-band discriminator, discussed by Dr. Phillips in the December 1957 issue, is that this avoids the two "side lobe" responses characteristic of a set with a fairly wide i.f. bandwidth and narrow discriminator. These side lobes occur at the ends of the linear part of the discriminator response and give rise to three tuning points instead of the usual one, though the two outside ones are weaker, and distorted.

By using a discriminator bandwidth that is wide compared to the i.f. bandwidth these side lobes fall well outside the i.f. pass band and are eliminated. Here it is not possible to tune to a side lobe, which has been known, giving rise to complaints of poor a.m. rejection!

Higher St. Budeaux, Devon. A. M. PEVERETT.

Discrimination at H.F.

IT is often suggested that our wives do not like "high-fidelity" because they are more sensitive than we are to the distortion in the treble made more liable by the wider frequency range. But, if this is the case, why is it that, at least in my experience, they never correctly tune in a radio receiver but always leave it sounding more or less "screechy"?

Edgware, Middx. D. J. KIDD.

"Do It Yourself" Interference

MAY I encroach upon your valuable space to answer Mr. Peter Stark Lansley's criticisms of my "Do it Yourself" Interference letter in your issue of December, 1957?

The last thing I want is to damp youth's enthusiasm for scientific knowledge, in fact I have given considerable help to many youngsters with their radio problems.

No, Peter Lansley, my guns were aimed at the designer of the set, not at the user. It would have been quite easy for him to have added an untuned buffer r.f. stage to the regenerative detector and this would have reduced to a negligible risk the possibility of radiating a signal capable of causing heterodyne interference with broadcast reception in the neighbourhood.

I, too, have made my regenerative one-valver although, I admit, this was in pre-broadcasting days. Even in the early nineteen-thirties, to which you refer, there were nothing like so many listeners as today so the chances of causing interference with an oscillating detector were correspondingly less.

I wonder what the Radio Department of the Post Office thinks of this set?

Godalming, Surrey. DOUGLAS WALTERS.

Unidentified TV Station

DURING the afternoons there is a strong TV signal on 55 Mc/s. The frame sync pulses are based on 60 c/s and there appears to be a central colour sub-carrier. Can anyone identify this transmission please?

Stornoway, Isle of Lewis. W. E. GARDNER. (GM3FYR).

PHYSICAL SOCIETY EXHIBITION

THE 42nd exhibition of scientific instruments and apparatus, organized by the Physical Society, will be held at the Royal Horticultural Society's Halls, Westminster, London, S.W.1, from March 24th to 27th. As in the past, the emphasis is on new developments in instruments and research techniques, and space is therefore restricted as far as standard instruments and equipment are concerned.

In all, some 130 manufacturers, research establishments and publishers will be participating, and we give below a selection of the firms in the radio and electronics field.

Admission to the show is by ticket available free from exhibitors or from the Physical Society, 1 Lowther Gardens, London, S.W.7. The exhibition opens on the 24th at 10.30, but admission is restricted to Society members and the Press until 2.0. It opens on other days at 10.0. The closing times on the four successive days are 7.0, 9.0, 7.0 and 4.30.

The Handbook published in connection with the exhibition, which forms a valuable book of reference to scientific instruments and apparatus, is obtainable from the Society, price 6s (postage 1s 8d).

Airmec
Associated Automation
Avo
B.T.H.
Baird & Tatlock
Baldwin Instrument Co.
British Physical Labs.
Burndept
Cambridge Instrument Co.
Cawkell, A. E.
Cinema-Television
Cossor Instruments
Dawe Instruments
Dobbie McInnes
Doran Instrument Co.
Dynatron Radio
Edwards High Vacuum
Ekco Electronics
Electronic Instruments
Electronic Tubes
Elliott Brothers
E.M.I. Electronics
English Electric Valve Co.
Ericsson Telephones
Evans Electroselenium
Ferranti
Fleming Radio
Fortiphone
Furzehill Laboratories
G.E.C.
Hatfield Instruments
Hilger & Watts
Isotope Developments
Johnson, Matthey
Kelvin & Hughes
Labgear
Lintronic
Megatron
Mervyn Instruments
Metropolitan-Vickers
Morgan Crucible Co.
Muirhead
Mullard
Murex
Nagard
Nash & Thompson
Panax Equipment
Philips Electrical
Planer, G. V.
Plessey
Pye, W. G.
Salford Electrical Instruments
Sanders, W. H.
Servomex Controls
Siemens Edison Swan
Solartron
Solus-Schall
Southern Instruments
Texas Instruments
Thompson, J. Langham
Tinsley, H.
Twentieth Century Electronics
Ultrasonoscope Co.
Venner
Wayne Kerr Laboratories

Measuring TV Aerial Performance

2.—Type of Test Equipment Required

By F. R. W. STRAFFORD*, M.I.E.E.

IN the previous article the selection of a suitable testing site was considered. It was deduced that, to cater for frequencies down to 40 Mc/s, the radiating and test aerials should be not less than 25 feet high and spaced at least 300 feet apart. These distances could be reduced, *pro rata*, if higher frequencies were at the limit of the range. It was also deduced that the standing-wave ratio, due to reflections at the test point, should not exceed 1.02 if directivity patterns involving maximum-to-minimum ratios of 30 dB were involved.

Having settled these factors the choice of the radiating and detecting apparatus can be considered.

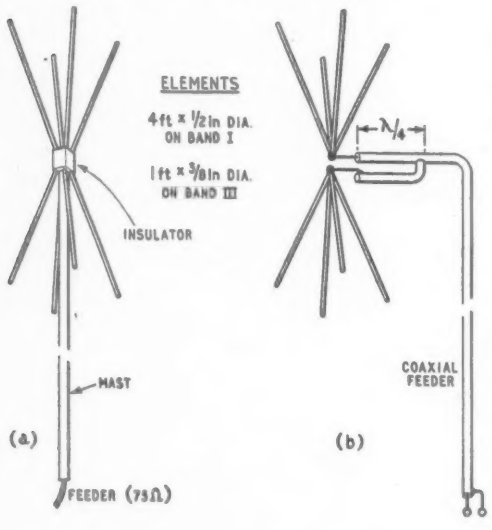


Fig. 5. A suitable wideband test aerial is shown at (a) and with balun at (b).

If the radiating aerial is a half-wave dipole the field intensity at the test point is given by the expression:—

$$E = \frac{90\sqrt{(P)}\,h^2}{\lambda d^2} \quad .. \quad .. \quad .. \quad (4)$$

where E is the field strength, in volts per metre.

P is the radiated power, in watts.

h is the height of the radiating and test aerial, in metres.

d is the separation of the aerials, in metres.

λ is the wavelength, in metres.

The e.m.f. appearing across the load resistance of a correctly terminated dipole, that is, fed through a 75-ohm feeder of negligible attenuation terminated with a 75-ohm resistor, is given by:—

$$e = \frac{E\lambda}{2\pi} \text{(volts)} \quad .. \quad .. \quad .. \quad (5)$$

Substituting in equation (4)

$$e = \frac{14.3\sqrt{(P)}\,h^2}{d^2} \text{ (volts)} \quad .. \quad .. \quad (6)$$

The approximate e.m.f. developed across the receiving dipole feeder termination at the test point can now be calculated in terms of the oscillator power fed to the radiator. It would be convenient to use a standard signal generator for this purpose and such instruments normally supply an open-circuit e.m.f. of 0.1 volt from an internal source impedance (resistive) of 75 ohms. Hence, the power available for radiation from a half-wave dipole with a radiation resistance of 75 ohms will be given by $P = 0.05^2/75 = 33.3 \times 10^{-6}$ watts. Putting $d = 91.44$ metres (300 feet), and $h = 7.62$ metres (25 feet), in equation (6), the voltage, e, appearing across the receiving dipole termination is given by:—

$$e = \frac{14.3\sqrt{(33.3\times 10^{-6})\times 7.62^2\times 10^6}}{91.44^2}\ \mu V \quad (7)$$

$$= \frac{14.3 \times 5.75 \times 10^{-3} \times 58 \times 10^6}{8370}$$

$$= 570\mu V \text{ (slide rule)}$$

The loss in the 300 feet of feeder to the test aerial must be taken into account. If the conventional semi air-spaced feeder similar to that used in fringe TV receiver installations is employed this will introduce approximately 10 dB loss at the high end of Band III. This, with the additional 2 dB loss in the radiator feeder will reduce e to about 140 μV.

Remembering that, in directivity measurements, a maximum front-to-back ratio of 30 dB is to be catered for, a value of less than 5 μV must be detected. The receiving detector would have to possess an extremely low noise factor to permit such a small voltage to be distinguished from the noise. Fortunately, there are a few signal generators which provide an open-circuit output of 0.5 volt which will increase e by a factor of 5 thereby increasing the lowest value to about 23 μV, which is a usable level if a detector with a low noise factor is used.

In any event, a signal generator supplying 0.5 volt will be a certain requirement for impedance measurements to be discussed in the third and final part of the article.

A signal generator is to be preferred over a simple oscillator because it incorporates a calibrated attenuator which can be used to compare the aerials under test. The stability of amplitude and frequency is very good, accurate frequency increments can be made, and the internal modulation can be switched in for identification purposes.

The radiating dipole must possess a wide bandwidth, that is, wider than the bandwidth of the aerial

* Consulting radio and electronic engineer.

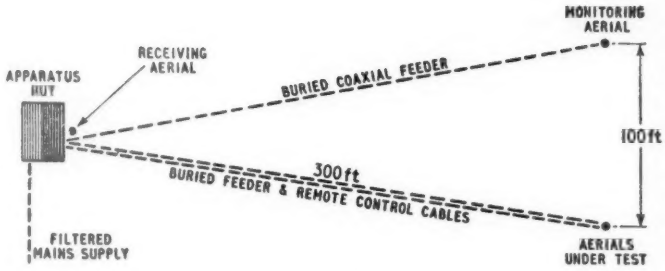


Fig. 6. Layout of testing site.

to be tested. If this requirement is omitted the variation, with frequency, of the gain and directivity will be greater than the true value.

Fig. 5(a) is a skeleton bi-conical half-wave dipole which, if dimensioned as shown, will cover the whole of Band I or III with less than 0.5 dB loss at the edges of the band. It can be used vertically or horizontally according to the desired polarization. This dipole is connected to the output of the signal generator through a low-loss feeder (75 ohms) and erected at a height of 25 feet close to the apparatus hut shown in the site layout, Fig 6. A balun is provided (Fig. 5(b)) to prevent radiation from the feeder.

The aerial to be tested must be compared with a standard and it has become customary, everywhere, to use a half-wave dipole for this purpose. It should be as near to ideal as possible so that the wideband balanced aerial of Fig. 5 should be used. This, and the aerial to be tested, are in turn mounted on the short rotatable mast mounted on the gimbal mast shown in Fig. 7. This design, using a suitable amount of counterweight, can be erected rapidly by one person and greatly facilitates the work. The rotator should preferably be an electric motor working through a reduction gear-train and designed to be remotely controlled from the apparatus hut because the presence of personnel below the mast is to be avoided, as variations can be introduced thereby. Some excellent rotators, designed for television aerials, are available in the U.S.A., and there does not appear to be any serious import restrictions in obtaining one or two for experimental purposes. These rotators are designed for remote table-top control and the little control panel is usually calibrated in degrees as well as compass bearings. Rotation is restricted to one revolution (360 degrees) so there is no danger of wrapping the feeder round the mast. Overshoot is eliminated by automatic braking and the amount of gear reduction is such that strong winds do not move the aerial from its set position. The r.f. feed from the aerial, and the supply cables to the rotator, are routed underground to the apparatus hut (Fig. 6).

The r.f. feed is connected to a sensitive tuned detector which may range from a well shielded modified television receiver, with a display meter connected in series with the vision diode detector, to an elaborate field-strength receiver costing several hundred pounds. The important requirements are low noise factor, excellent shielding, good gain stability and freedom from frequency drift, if of the superhet type. An important point to remember is that the apparatus is used only as a detector so that the absolute gain is not required to be known, all the measurements being based on comparison with the standard aerial.

If the arrangements so far described are carried out, measurements can proceed along the following lines:— The output of the signal generator is set to about 30 dB below maximum at the desired frequency. The standard dipole is erected and the gain of the detector adjusted so that a convenient reference is established on the display meter. The standard aerial is then replaced by the aerial to be tested and the attenuator on the signal generator is readjusted to restore the reference reading on the display meter. The ratio of the attenuator readings is the gain or loss of the aerial under test compared with the standard. To obtain the directional response the measurements are repeated at 5-degree intervals on the rotator

Unfortunately serious errors may creep in if the foregoing procedure is adopted. An interval of at least an hour occurs between the first and last measurement during which time the detector gain and the output from the signal generator may have drifted, or some fault develop in the aerial under test. For this reason it is strongly recommended that a monitoring aerial be used. This can be identical with the standard dipole and should be erected at a height of about 25 feet and placed about 100 feet to the side of the test point as shown in Fig. 6. In these circumstances it will have a negligible effect upon the measurements. During the course of measurement the receiving detector may be switched over to the monitor and any amplitude drift restored by means of the detector gain control. In this way all uncertainties are removed and the overall accuracy is determined solely by the accuracy of the signal generator attenuator. There is no reason why the output of the signal generator should not be set permanently to maximum and a well-screened, accurate, attenuator with an input and output resistance of 75 ohms, connected in front of the detector. The procedure is the same but there is a distinct advantage in that the aerial under test is more likely to be correctly terminated than if coupled to the first tuned circuit of the detector by

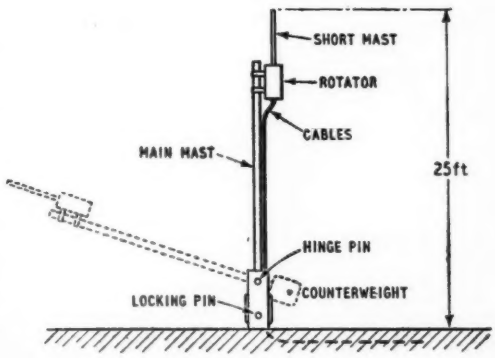


Fig. 7. Rotatable mounting for the test aerial.

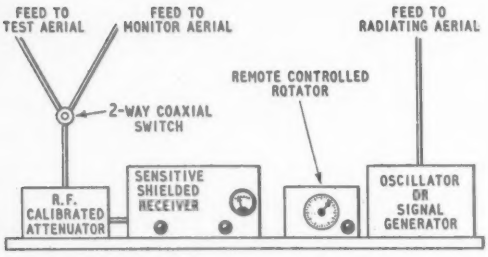


Fig. 8. Layout of the test apparatus.

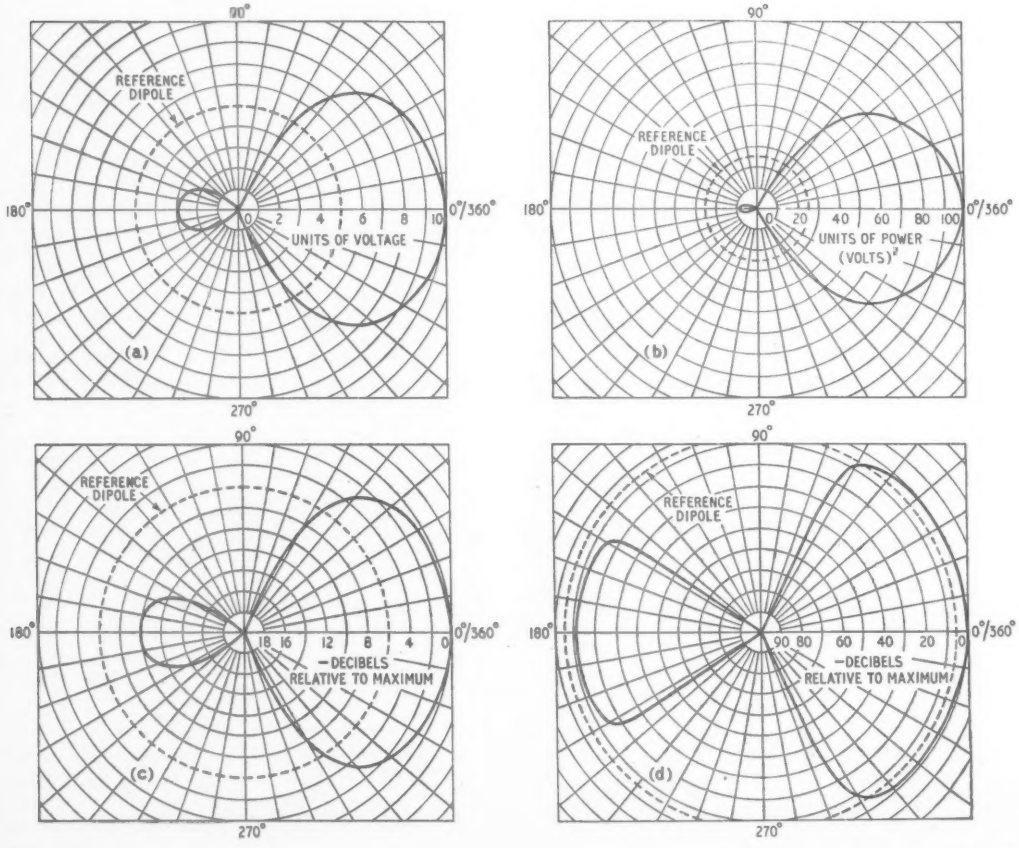
the usual coil coupling or tapping method, which generally causes the input impedance to vary quite a lot with frequency, and to be reactive most of the time! If pre-detection attenuation is not used it is desirable to terminate the test aerial feeder with a 75-ohm resistor and pad this off from the detector input through several hundred ohms, thereby reducing the effective sensitivity of the detector.

Fig. 8 is a layout of the apparatus which includes the preferred pre-detection attenuation and a coaxial switch for switching to either the monitor or test aerial. A check should be made on the possibility of direct pick-up between the detector and the signal generator by the simple process of disconnecting all aerials and terminating the far ends of the feeders with 75-ohm resistors. With maximum output from the signal generator and maximum detector gain the residual pick up should be at least 20 dB below the normal display reference level.

Before serious work is attempted some trial measurements should be taken using a quarter-wave spaced dipole and reflector adjusted for maximum gain. The improvement over the standard dipole should lie between 3 and 4 dB. If the reflector is made into a director, by shortening it and reducing the spacing to one-tenth wavelength, the gain should lie between 4 and 5 dB. Values outside these limits should be treated with great suspicion and the cause traced by step-by-step analyses.

Expressing and Plotting the Results.—*Gain.*—The gain of the test aerial relative to the standard dipole is the maximum gain measured on the axis of the major lobe of the directional response curve. It is customary to express this in dB. Since the feeder termination is resistive either voltage or power ratios expressed in dB give the same answer because

Fig. 9. Different presentations of a polar diagram; in terms of (a) voltage, (b) power, (c) 20 dB attenuation at chart centre and (d) 100 dB attenuation at centre.



$10\log P_1/P_2 = 20\log E_1/E_2$ since P is proportional to E^2. It is usual to measure the gain at the vision carrier frequency but it is desirable also to give the figure for the sound carrier frequency if the aerial is likely to be fairly selective, e.g., a Yagi with several elements. In the case of aerials designed to cover more than one adjacent channel a gain-frequency curve should be taken over the range claimed.

There have been suggestions that results have been made misleading by measuring the gain against a standard half-wave dipole and adding 2.2 dB as if the aerial had been compared against an isotropic radiator. But the latter is a hypothetical radiator, convenient in mathematical analysis, but which could not be constructed in practice. Mathematically it is defined as an aerial capable of receiving equally well in *all* vertical and horizontal directions. Such an aerial does not exist. Adding 2.2 dB however, to an aerial with a gain of, say, 4 dB relative to a half-wave dipole certainly glamorizes the result—*caveat emptor*!

Azimuthal Directional Response.—It is usual to plot this in 5-degree intervals in polar co-ordinates, (Figs. 9(a)-(d)), but one must beware of the choice of the amplitude scale. The directional response of a typical H aerial (Fig. 9(a)), is plotted in terms of voltage. The same characteristics plotted in terms of power (voltage squared) look a lot better, (Fig. 9(b)). Plotted in dB, where the centre of the chart is made to coincide with 20 dB, it does not look so good (Fig. 9(c)). When the centre of the chart is 100 dB the properties look even worse (Fig. 9(d)). Directional response characteristics cannot, therefore, be compared merely by casual inspection of the polar diagrams *unless the amplitude scale and notation are standardized*. The writer suggests that the response is plotted in dB, and that the centre of the co-ordinate system be 40 dB, since the maximum front-to-back ratio rarely exceeds this value. A great deal of unintentional misrepresentation could be avoided by adopting such, or similar, standards. The directional response should be plotted in heavy lines and that of the standard reference dipole in dotted lines superimposed.

Vertical Directional Response.—It is almost an impossibility to measure this down to Band-I frequencies as it would be necessary to place the aerial under test, at various points, on a huge, insulated, semicircular platform or gantry raised above ground on a radius of 300 feet! An approximate measurement may be made by placing the radiator and test aerial in the horizontal plane (in the case of an aerial designed for vertical polarization), and vice versa for a horizontally polarized aerial. Measurements are then made by the procedure outlined and the results may be regarded as a fair, but doubtful, approximation to the real thing.

Furthermore, it could be argued that the aerial so measured is rarely installed in the manner recommended for the tests; it will, in practice, be erected on a mast, chimney, wall, or in the loft, or even in the viewing room. This being so, why bother to make any measurements, or, at least why not introduce more practical conditions! The answer is simple. Statistically, if a few thousand aerials type A and B, in which type A is the better under the tests outlined, are placed in a variety of sites under normal housing conditions, *on average* type A will give the best picture-to-noise performance. Occasionally the inferior aerial will be the better due to adventitious circumstances. In any event, how else is the performance to be measured?

The general problem of measurement, as discussed in this article, is not confined to television aerials and can be extended to aerials for telecommunications, beacons, radar etc., where the user has the advantage of being able to select a suitably isolated site. In these circumstances the value of aerial comparisons based on the foregoing principles and procedure cannot be doubted.

(*To be concluded*)

CLUB NEWS

Birmingham.—Modern trends in oscilloscope design will be covered by G. J. Williams (Solartron) when addressing members of the Slade Radio Society on March 14th. Two B.T.H. films will be shown on March 28th. Meetings are held at 7.45 at the Church House, High Street, Erdington. Sec.: C. N. Smart, 110, Woolmore Road, Erdington, Birmingham, 23.

Birmingham.—Two-metre mobile operation will be discussed by T. Tallboys (G2ATK) at the Midland Amateur Radio Society meeting on March 18th at 7.30 at the Midland Institute, Paradise Street. Sec.: C. J. Haycock (G3JDJ), 360, Portland Road, Birmingham, 17.

Bradford.—D. G. Enoch (G3KLZ) will speak on amateur television at the Bradford Amateur Radio Society meeting on March 4th at 7.30 at Cambridge House, 66, Little Horton Lane. Sec.: D. M. Pratt (G3KEP), 27, Woodlands Grove, Cottingley, Bingley.

Bury.—At the meeting of the Bury Radio Society on March 11th G. Openshaw (G2BTO) will speak on preventing TVI (television interference). The meeting will be at 8.0 at the George Hotel, Kay Gardens. Sec.: L. Robinson, 56, Avondale Avenue, Bury.

Leeds.—The first Northern Mobile Rally is being organized for Sunday, April 13th, by the Spen Valley Amateur Radio Society in co-operation with societies in Leeds and Bradford. Central stations radiating on 80 and 2 metres will be sited in the grounds of Harewood House. Further information from N. Pride, 100, Raikes Lane, Birstall, near Leeds.

Reading.—Lt.-Col. Bower will speak on his experiences as a transmitter in the Far East to members of the Reading Amateur Radio Club on March 29th at 7.30 at the Broad Street Headquarters. Sec.: A. B. Hutchence (G3IKA), 12, Chiltern Bank, Peppard, Oxon.

Sidcup.—The March meeting of the Cray Valley Radio Club will be the A.G.M. Meetings are held on the fourth Tuesday of each month at 8.0 at the Station Hotel, Sidcup. Sec.: S. W. Coursey (G3JJC), 49, Dulverton Road, London, S.E.9.

Wanstead.—The Wanstead and Woodford Radio Society has been reorganized, and is now known as the Wanstead, Woodford & District Radio Club. The H.Q. is still at Wanstead House, The Green, London, E.11, where members have use of a self-contained building in the grounds. M. M. D'Arcy (G3AGL) continues as chairman with Ken Smith (G3JIX) as secretary. A series of lectures on morse and radio theory are arranged for Wednesday evenings at 7.30, and general meetings are held each Friday at 8.0.

Wellingborough.—Mullard's film lecture on the history and development of the cathode-ray tube will be given at the meeting of the Wellingborough & District Radio and Television Society on March 13th. The meeting will be held at 7.30 at the Wellingborough Technical College. Sec.: P. E. B. Butler, 84, Wellingborough Road, Rushden.

Scatter Propagation

DIGEST OF PAPERS SUBMITTED TO THE I.E.E. SYMPOSIUM

A SYMPOSIUM on long-distance propagation on frequencies above 30Mc/s was held at the Institution of Electrical Engineers on 28th January, at which the forenoon session was devoted to the subject of forward scatter propagation *via* the ionosphere, and the afternoon and evening sessions to that of propagation to distances beyond the horizon *via* the troposphere. There were eleven papers on the first subject and twelve on the second and a considerable portion of each session was devoted to animated discussion on the contents of the papers. From this mass of detailed material we can only bring out some points of general interest, as they appeared to us.

Ionospheric Forward Scatter Propagation.—The focus of attention was mainly on results obtained over the ionospheric forward scatter circuit between Gibraltar and places in the U.K., at distances of approximately 1,100-1,300 miles (1,760-2,080 kilometres) on frequencies of 37, 48 and 70Mc/s. The scattering appears to take place at a height of 80-90 kilometres, this being assumed to be in the ionized region at the bottom of the E layer, it being necessary to employ directive aerials to "illuminate" a scattering area at this height, which is mutually "visible" to the transmitting and receiving aerials. For the longer distances some allowance must be made for a small amount of "bending" in the troposphere. The strongest signals appear to occur in the frequency range 30-50Mc/s, and their structure indicates that they are composed of a low-level fluctuating background on which are imposed high-level bursts. The low-level component has been ascribed to scatter from "turbulences" in the ionization, but there seems to be considerable uncertainty as to whether this is, in fact, the cause. The high-level bursts are of fairly certain origin, and interesting evidence of a diurnal movement across the great circle path in the direction from which they come was given as proof that they are due to meteoric activity. As a result of variations in the incidence of their sources the scatter signals have a pronounced diurnal variation, with a maximum at 0400-1200g.m.t. and a minimum around 1800g.m.t., the latter corresponding to a minimum of meteors. They also have a seasonal variation such as to produce maxima in July and December and minima in March and October. However, a scatter circuit does not require frequency changes and is not interrupted by ionospheric disturbances.

Due to the generally low level of the scatter signal and the necessity for the use of high-gain receiving aerials, the system is particularly susceptible to the effects of interference, and a truly formidable list of interference sources which were observed within the useful frequency range was given. As if this were not bad enough, there is also, under high sunspot activity conditions, the problem of self-interference, for back radiation from the transmitter can be scattered at the ground and then propagated in a forward direction *via* the F_2 layer so as to cause interference at the receiver. There is also interference from round-the-world echoes. Again, particularly when sporadic E is present, the scatter signals can be propagated in an unwanted manner so as to interfere with other services.

In fact it appeared evident from some of the papers, and more particularly from the discussion, that many people are of opinion that ionospheric scatter systems are severely limited in scope, and have few useful applications in the field of civil communications, though their military applications may be advantageous. Nevertheless in the intensive study which has been given to the subject much useful knowledge about the ionosphere and about the appropriate "hardware" has been gained. It is only fair to add that, despite the difficulties, the U.S. authorities are using several such links upon an operational basis.

Tropospheric Scatter.—The 12 papers devoted to measurements and predictions of field strength of signals propagated beyond the radio horizon covered wavelengths of from 10 metres down to 3·2 cm; 30Mc/s to 9,600Mc/s. The lower frequencies are, however, more suitable for ionospheric scatter propagation, but it must not be thought that under no conditions will the lower frequencies be propagated in the troposphere. As far back as the late 1920s and early 1930s Guglielmo Marconi carried out some interesting investigations on beyond-the-horizon transmission on 30Mc/s achieving ranges of 170 miles with the radio horizon at about 20 miles. Later experiments on 600Mc/s, then regarded as in the microwave region, demonstrated that even with the crude (by modern standards) apparatus then available, reception up to nine times the optical range for the siting of the aerials was achieved. In retrospect these tests were most significant, but at that period the pressing considerations of world-wide coverage took charge and further activities were directed along the more profitable channels of short waves.

Amateur workers continued to explore the 60-Mc/s frequencies, however, and a suitable tribute was paid in the discussion to their contributions in the 1930s to accumulated knowledge on v.h.f. propagation *via* the troposphere.

From the nature of the papers submitted to the symposium it is very apparent that over the past five to six years a vast amount of scientific data has been compiled on radio-wave propagation in the troposphere beyond the radio horizon. It is now generally accepted that reasonably reliable communication is practicable at distances between 100 and some 500 to 600 miles, utilizing tropospheric scatter technique and that the most suitable radio frequencies are those above about 300Mc/s. Lower frequencies are propagated in this medium and under certain con-

(*Continued on page* 125)

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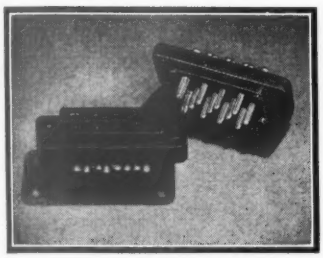

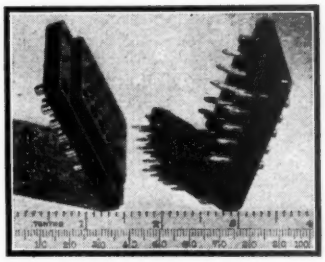

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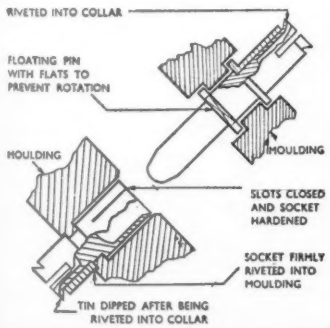
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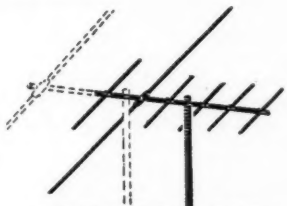

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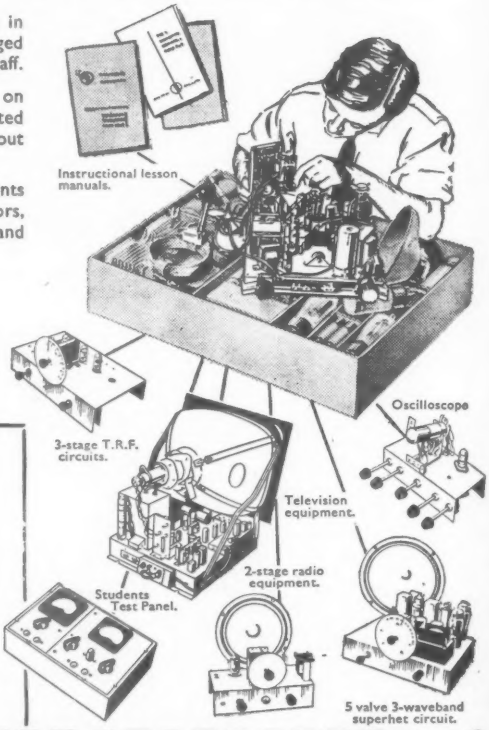

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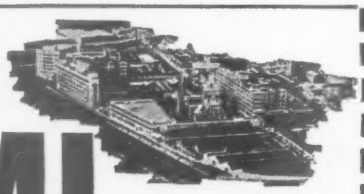

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ditions television frequencies of 40Mc/s upward, and v.h.f. broadcasting frequencies of 85 to 95Mc/s, can be received at surprisingly long ranges as shown by measurements contained in one of the papers.

It is also known now that, unlike the ionosphere scatter systems, the troposphere scatter transmissions can support a wide bandwidth making multi-channel communication systems and long-distance television transmission possible. From the interference by Continental stations that U.K. viewers have experienced during the past year or so, and by the interference to v.h.f./f.m. broadcast that is caused by Continental stations and experienced mainly on the Channel coast, there is no doubt that tropospheric scatter propagation is definitely operative on 85 to 95Mc/s. In this connection one of the papers was devoted to the results of a series of tests conducted by the B.B.C. in 1946-1947 over distances ranging from 135 miles to 600 miles and on frequencies from 41 to 68Mc/s, 88 to 95Mc/s, 180 to 200Mc/s and 470 to 585Mc/s over land and over sea. The main purpose of the investigation was to compile data that would assist in the planning of common-frequency working of TV and v.h.f./f.m. stations in the United Kingdom. Later these results were handed over to the C.C.I.R. as a contribution to the tropospherical data being compiled for international use.

Apart from the microwave investigations, for which paraboloid-type aerials were customarily used, aerial systems for the lower frequencies were generally Yagis stacked vertically or arranged as side-by-side systems or a combination of both were often used. From 200Mc/s up, these were often backed by a reflecting screen in place of element-type reflector rods. These systems sufficed, without unduly high transmitter radiated powers, to enable investigations to be conducted up to 400 or 500 miles.

The nature of the received signal has led to the conclusions that the so-called scatter form of propagation is more often than not a combination of reflection and scatter, the reflection components often predominating and giving rise to unusually strong signals beyond the radio horizon. There is a sharp fall in field strength as a rule just beyond the horizon threshold and this may amount to 50dB below the free-space field for the equivalent distance. There are diurnal and seasonal fluctuations in field strength which vary considerably with the working frequency and signals are generally stronger at night than during daylight by a matter of about 8dB, while the variation over the 24 hours can amount to about 13dB. Signal strength is generally lower in winter than in summer. These figures apply to the 3,000-Mc/s region and are slightly smaller for lower frequencies and larger for higher frequencies; they can be taken as fair averages. As 3,000Mc/s and higher signals are enhanced by fog and deteriorate in rain, while over the whole range aircraft echoes are very significant.

These are general observations, but signals are subject to considerable variation in strength, as the resulting signal beyond the horizon usually consists of an incoherent signal, due to reflections from irregularities in the refractive index of the troposphere, or atmospheric turbulence, or other effects and a coherent signal arising from some kind of elevated reflecting layer in the troposphere. This can be either a sharp discontinuity in the refractive index or in the temperature or humidity gradient. Reflecting layers can also be formed by other atmospheric conditions. When it amounts to an inversion, temperature or humidity, strong and sustained reflections occur giving rise to abnormally strong signals in the trans-horizon region. The height in the troposphere of these reflecting layers can be anything up to the limit, which is variously assumed to be about 6 miles above the ground, so that radio reception in aircraft flying at heights up to about 30,000ft is subjected to the variations prevailing in the troposphere. Some investigations have been made and are at present continuing into reception conditions in aircraft flying above the tropopause. This is an arbitrary boundary which can fluctuate between 30,000 and 40,000ft according to prevailing conditions and other factors.

Despite the vast amount of data that has accumulated and the conclusions reached regarding the probable behaviour of radio waves beyond the radio horizon from postulated theories, there is still sharp divergence in opinion as to the primary mechanism of propagation in the troposphere. Some authors of papers were strongly in favour of reflections contributing the major part, others held that scatter in its more limited sense was the dominating factor, but the true explanation is more than likely a contribution of all known mechanisms that project a signal into the trans-horizon region. And several speakers expressed this view in the subsequent discussion.

There is still much to be learnt about this medium of wave propagation; for example, at the highest frequencies explored, *circa* 10,000Mc/s, there appear to be factors which influence propagation and which cannot be satisfactorily explained from available data. But no doubt time will rectify this omission, as it does in most problems of a scientific nature, where, when sufficient evidence is forthcoming, theories can be formulated to account for all the phenomena encountered.

Commercial exploitation of trans-horizon propagation does not seem to have gone very far, which may be due to the incomplete data so far compiled, or to the time it takes to assimilate the data and formulate conclusions that are convincing to the commercial mind as well as to the physicist. It is admitted that at times signal strengths can be very low and, of course, economics enter into the picture, since it is unrealistic to install transmitting and receiving equipment of adequate power and sensitivity to cope with the worst conditions, whereas half the power and sensitivity or less would suffice for most of the working time. Cost of aerials has also to be taken into account, since for all forms of scatter communication relatively high-gain aerials have to be used.

It was mentioned in the discussion that in an overseas chain of microwave radio links in which the transmitting and receiving frequencies were repeated at intervals signals occasionally hopped over the intermediate relays to the next one using the same frequency. The reliability factor was not quite good enough to justify closing down the intermediate relays, but no doubt if equipment more in keeping with the signal strengths in the trans-horizon region had been in use some economy of this kind might have been possible for part of the working time. It would seem, therefore, that, for the present at least, line-of-sight, or just-over-the-horizon, spacing of relay links is likely to remain the basic policy for long-distance microwave links.

Magnetism in Materials

(Continued from p. 74 of previous issue)

3. Commercial Magnetic Materials and Domain Theory

By D. H. MARTIN, Ph.D.

DURING the last 60 years the systematic search for new and better alloys for application in electrical and communications engineering has produced a remarkable range of materials whose technologically important properties—permeabilities, coercivities, etc.—are extremely sensitive to minute quantities of impurities and residual stresses and to variations in heat, mechanical and magnetic treatments. The domain theory which I have outlined in the foregoing pages sets out to relate these properties to the basic *structure-insensitive* constants of the materials, that is to the spontaneous magnetization I_s, the anisotropy constants K, and the magnetostriction constants λ. These are hardly affected by impurities and strains. In doing so it has clarified a bewildering collection of empirical data and, in recent years, has served as a valuable guide in the development of special materials, as I plan to illustrate by reference to some commercially important materials.

The usefulness of a magnetic material is determined largely by the shape and size of its *hysteresis loop* though its mechanical and electrical properties and its cost will often have to be considered. When a sample is subjected to an alternating field the induced magnetization varies cyclically as illustrated by the family of hysteresis loops in Fig. 14, each loop being appropriate to a particular peak field. The hysteresis properties of a material are often adequately described by quoting values for its coercivity, its initial and maximum permeabilities, its saturation induction and its hysteresis loss. These may be defined with the aid of Fig. 14. The magnetic induction B induced in a specimen by a field H is equal to $(H+4\pi I)$ (in the e.m.u. system of units)

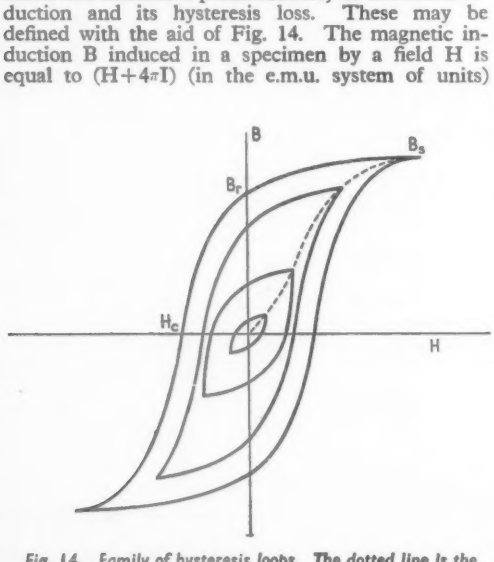

Fig. 14. Family of hysteresis loops. The dotted line is the normal magnetization curve.

where I is the intensity of magnetization of the specimen. B is more directly measurable than I and is therefore more commonly quoted than I itself. The hysteresis loops in Fig. 14 are B versus H loops. In large fields, I, and therefore (B-H), reach constant values (when all the domains are aligned with the field) and this value of (B-H) is the *saturation induction* B_s. The coercive force is that field required to reduce the induction to zero, and for the loop in which saturation is attained the coercive force is known as the *coercivity*, H_c, of the material. The "normal magnetization curve" is the dotted line in Fig. 14, that is the line joining the tips of successive loops. The *permeability*, μ, is the ratio of B to H for a point on the magnetization curve, and clearly depends on the field, generally as shown in Fig. 15. The *initial permeability* μ_o is that in very low fields and μ_m is the *maximum permeability*. I have already described how hysteresis arises from irreversible domain wall motion, and with this there is associated a generation of heat. It can be shown that the hysteresis heat per cycle W_H is directly proportional to the area enclosed by the hysteresis loop. That this is an important specification for a material to be used in a power transformer core is brought home by the estimate of Yensen in 1936 that about 0.4% of all the electrical power then used in the United States was dissipated as heat in transformer cores. Hysteresis loss is also important in communications equipment, not only as a measure of lost power but because hysteresis causes harmonic distortion.

The electrical resistivity ρ of a material is normally an important specification. This is because of the undesirable effects of *eddy currents* which are induced in core materials, by ordinary electromagnetic induction, when their intensity of magnetization is changing with time. They are greater the higher the frequency of alternation of H. Eddy currents dissipate heat by joule heating and thus cause power loss. In high-frequency applications they also limit the penetration of the magnetic field into a core material and therefore cause an apparent decrease of μ with frequency. Eddy currents are smaller the larger the resistivity of a material, and, for high-frequency applications a large ρ is therefore desirable. In order to reduce the eddy-current effect, transformer and inductor cores and the magnetic parts of motors and generators are normally laminated, that is made up of thin sheets which are electrically insulated from each other. Power transformer laminations are usually 0.014 in thick, and for high-frequency applications cores are made of strip, sometimes as thin as 0.002 in, or of powdered alloys.

The coercivities of commercially important materials fall within the range from 0.004 oersted up to more than 4,000 oersteds, that is over six

orders of magnitude. Maximum and initial permeabilities vary over almost as wide a range from about 1.0 up to $\mu_m \approx 1{,}000{,}000$ and $\mu_o \approx 100{,}000$. Materials may be generally classified as magnetically *soft* or *hard*. Soft materials are those having H_c less than an oersted or so, and high permeabilities, and are mainly used in transformers, inductors, motors and generators; in fact in all devices requiring large, and sometimes rapid, changes in induction upon the application, removal, or reversal of small applied fields. Hard materials are those with H_c greater

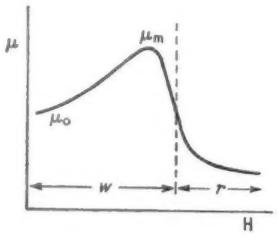

Fig. 15. Variation of permeability μ with field H. The drop in permeability occurs when wall motion, ω, gives way to rotation, r.

than about 50 oersteds and are used to construct the permanent magnets required for loudspeakers, microphones, microwave generators and numerous other devices. With the application of magnetic materials in recent years as computer storage and register elements there has been developed a third class of materials, those with rectangular hysteresis loops. In the following pages I shall discuss some of the important materials belonging to each of these three groups.

Magnetically Soft Materials.—Iron is the most readily available magnetic element and almost all of the commercially important materials contain a large proportion of it. For reasons which will be given later it is seldom used magnetically in an unalloyed form except in large electromagnetic machinery. During the last 60 years, however, extensive magnetic studies have been made of pure iron and they illustrate remarkably the importance of purity and freedom from mechanical strain in achieving magnetic softness. Improvements in the techniques of purification since 1900 have led, for example, to an increase of more than a thousandfold in the maximum permeability of laboratory specimens. High purity commercial iron has μ_m in the range 5-10,000 and H_c about 1.0 oersted. Laboratory specimens, purified by a series of annealing treatments in vacuum and in hydrogen at temperatures up to 1,400°C, followed by slow cooling at less than 5°C per minute to avoid residual mechanical stresses, have μ_m as high as 350,000 and H_c about 0.01 oersteds. I have described earlier how the domain theories explain the extreme sensitivity of permeability and coercivity to minute quantities of impurities and stresses. Imperfections of these kinds impede the movement of domain walls. The impurities which are in practice most troublesome are carbon, oxygen, nitrogen and sulphur. These have low solubility limits in iron; that is to say, when present in quantities greater than 0.007%, 0.01%, 0.001% and 0.02% respectively, the impurity atoms no longer fit into the iron crystal lattice but form precipitated islands or "inclusions" of various chemical compounds; for example carbon may appear as a precipitate of cementite (Fe_3C). These inclusions are thought to be most effective in impeding wall movement when a given amount of impurity is distributed through the material in the form of inclusions having diameters about equal to the width of a domain wall, in iron about 10^{-5} cm. Even when present in amounts less than the solubility limit impurity atoms distort the lattice, setting up stresses which impede wall motion. The effect of carbon and oxygen on the hysteresis loss of pure iron is illustrated in Fig. 16. A serious defect of early magnetive irons was "ageing," the deterioration of the soft properties with time. This is due to a slow precipitation of impurities into inclusions of a more effective size.

For applications involving alternating fields iron alloyed with up to 5% *silicon* is superior to unalloyed iron, and is used in large quantities in power transformers, motors and generators. The added silicon brings about several improvements which lead to a greatly reduced power loss. First, the electrical resistivity increases approximately in proportion to the percentage of silicon, rising from about 14 micro-ohm-cm for unalloyed iron to about 80 micro-ohm-cm for 6% silicon-iron, a sixfold increase. This leads to a considerable reduction in eddy-current losses. Secondly, the addition of silicon to iron increases its permeability and reduces its coercivity, in other words decreases its hysteresis loss. Unlike the impurity elements, silicon forms solid solutions in which the silicon atoms simply replace some of the iron atoms in the crystal lattice without undue distortion. The improved soft properties are due partly to the chemical reactions, between the silicon and the impurities initially present in the iron, which take place during the preparation of the material. These reactions lead to the removal of some of the impurities as slag, and to carbon being precipitated in the form of graphite, rather than cementite or pearlite. In this form it is less harmful, probably due to its coagulation into larger inclusions. Ageing is completely

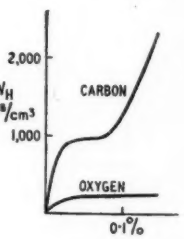

Fig. 16. Dependence of the hysteresis loss per cycle, W_H, at a peak induction of 10,000 gauss, on the percentage of carbon and oxygen in iron. (Yensen)

absent in good silicon-iron alloys. Another contributory factor to the increased softness resulting from the addition of silicon is its affect on the anisotropy constant K and the magnetostriction constant λ. These are both reduced by the silicon and the domain theory indicates that the impedance offered to wall motion by a given distribution of impurities is less the smaller K; and the smaller λ the less important are the residual strains. The addition of 7% silicon reduces K by 70%, and λ falls to zero, and extremely soft properties are exhibited by alloys containing 6-7% silicon. Two factors severely limit the usefulness of alloys containing more than about 4½% silicon, however. First, the saturation induction B_s is reduced by the addition of silicon, 4% silicon causing a 10%

Fig. 17. Orientation of the cubic axes of the crystals in grain-oriented silicon-iron.

decrease in B_s, and for applications where a high induction is the prime requirement (in motors and generators for example) alloys containing 1.5% silicon or less are therefore used. Secondly, alloys containing more than 5% silicon are extremely brittle. For transformers, where a high permeability, rather than a high induction, is required, the silicon content employed is normally about 4%, and typical values for μ_o, μ_m, and H_c are respectively 800, 8,000 and 0.6 oersteds.

The reduced influence of impurities and strains when K and λ are low is demonstrated in a remarkable way by a ternary alloy containing silicon, aluminium and iron. By adjusting the proportion of these materials it is possible to make an alloy for which *both* K and λ are almost zero. This occurs at about 9.6% silicon and 5.4% aluminium; as the silicon and aluminium contents are varied through this critical composition K and λ change sign. This alloy is magnetically very soft with $\mu_o \approx 35{,}000$, μ_m about 120,000, H_c about 0.5 oersted and $B_s \approx 10{,}000$ gauss. The applications of this alloy, which is known as Sendust, are very restricted due to its brittleness. The production of very soft materials by adjusting composition to give near-zero K and λ has great commercial importance, however, as will be illustrated later in the discussions of certain nickel-iron alloys and ferrites.

I return now to the silicon-iron alloys to discuss a comparatively recent development in their preparation which has led to greatly improved magnetic properties. Ordinary "hot-rolled" 4% silicon-iron for power transformer cores is prepared by rolling the hot alloy into sheet, by successive passes and re-heating, followed by an anneal at about 900°C. Laminations are then stamped out of the sheet, which is normally 0.014 in thick, and for the best performance the strains remaining after stamping are relived by a further anneal. The new method of treatment involves rolling the alloy when it is cold, not hot, and this results in the growth, during subsequent annealing treatments, of crystals which have a distinct preferred orientation. The situation is illustrated in Fig. 17. The crystals in the sheet are still irregularly shaped, but their crystal axes, which fix the atomic arrangement within them, are not randomly oriented. Each crystal lies close to the orientation illustrated in the figure, that is with the [100] direction, an "easy" direction in terms of domain theory, parallel to the rolling direction of the sheet. The sheet therefore approximates to a single crystal. Now in an earlier section dealing with domain processes I described how a single crystal may be magnetized to saturation in a very low field provided the field is applied in an "easy" direction, that is a [100] direction in iron. For fields in [110] and [111] directions the induction in a crystal rises rapidly to $B_s/\sqrt{2}$ and $B_s/\sqrt{3}$ respectively, but from there onwards larger fields are required to increase the overall induction, by domain rotation. In a polycrystalline sample in which the crystallites, or "grains," are randomly oriented, wall motion will therefore produce a rapid rise to somewhere between B_s and $B_s/\sqrt{3}$, in fact to $B_s/1.5$ in silicon-iron. In *grain-oriented* materials, however, when the field is applied in the rolling direction, domain wall motion will lead to an induction close to B_s, just as it does in a single crystal magnetized in an easy direction. The great improvement in the induction thus attained at fields greater than about one oersted is illustrated in Fig. 18. (There is also an increase in the permeability at inductions below the "knee" of the magnetization curve, and this is not as readily explained. It is probably due to a preferred domain orientation arising from the difference in dimensions of the sheet in the three [100] type directions.) The permeability perpendicular to the rolling direction is less than that parallel to it, as would be expected since this direction is close to the [110] directions of the crystallites. Unless the field applied to a specimen is everywhere parallel to the rolling direction full advantage cannot be taken of the improved properties. If possible, therefore, strip-wound cores rather than "E" or "I" laminations should be used. Cold-rolled grain-oriented 3% silicon-irons are available under various trade-names, among them Hypersil, Crystalloy and Alphasil, and typical values for μ_o, μ_m, and H_c are 2,000, 30,000 and 0.25 oersteds, when magnetized in the optimum direction; the improvement over non-oriented material is very marked. They are used in high-efficiency power-frequency transformers as well as in audio-frequency power-transformers, chokes, pulse transformers, etc., in which low losses are essential. For these applications cores are normally strip-wound using material selected from a range of thicknesses down to 0.002 in.

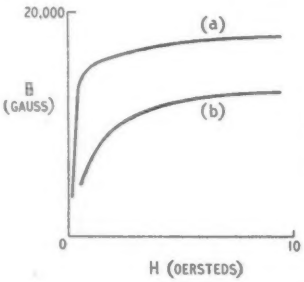

Fig. 18. Magnetization curves for (a) grain-oriented 3% silicon-iron and (b) 4% non-oriented silicon-iron.

Certain alloys of iron with between 40% and 90% nickel have much higher permeabilities, smaller coercivities and hysteresis losses, and larger resistivities than the silicon-irons. For example, typical values for H_c, μ_m and μ_o are 0.3 oersted, 25,000 and 2,500 respectively for 45% nickel-iron ("45-Permalloy") and 0.05 oersted, 100,000 and 8,000 for 78.5% nickel-iron ("78-Permalloy"). Hysteresis losses at a peak induction of 5,000 gauss are of the order ten times lower than for non-oriented silicon-iron. Compared with iron, however, the saturation induction is low; 16,000 gauss for 45% and 10,800 gauss for 78.5% nickel-iron compared with 21,500 gauss for iron. It is partly due to this that they have not replaced silicon-iron in electrical power installations, generators, motors and transformers, which operate at high inductions. Their applications are also restricted by their high cost, which arises from the high nickel content and the refined

(*Continued on page* 129)

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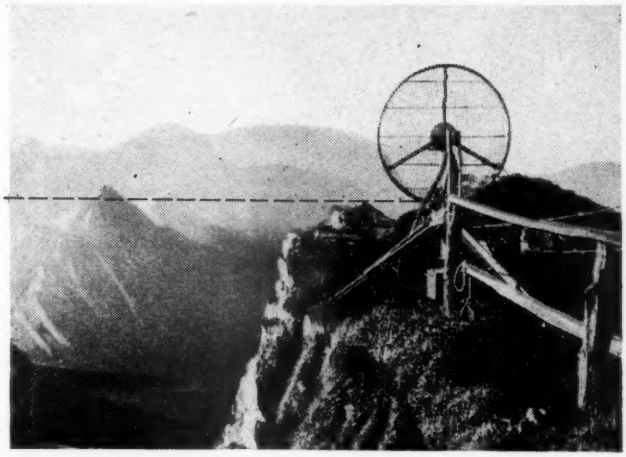

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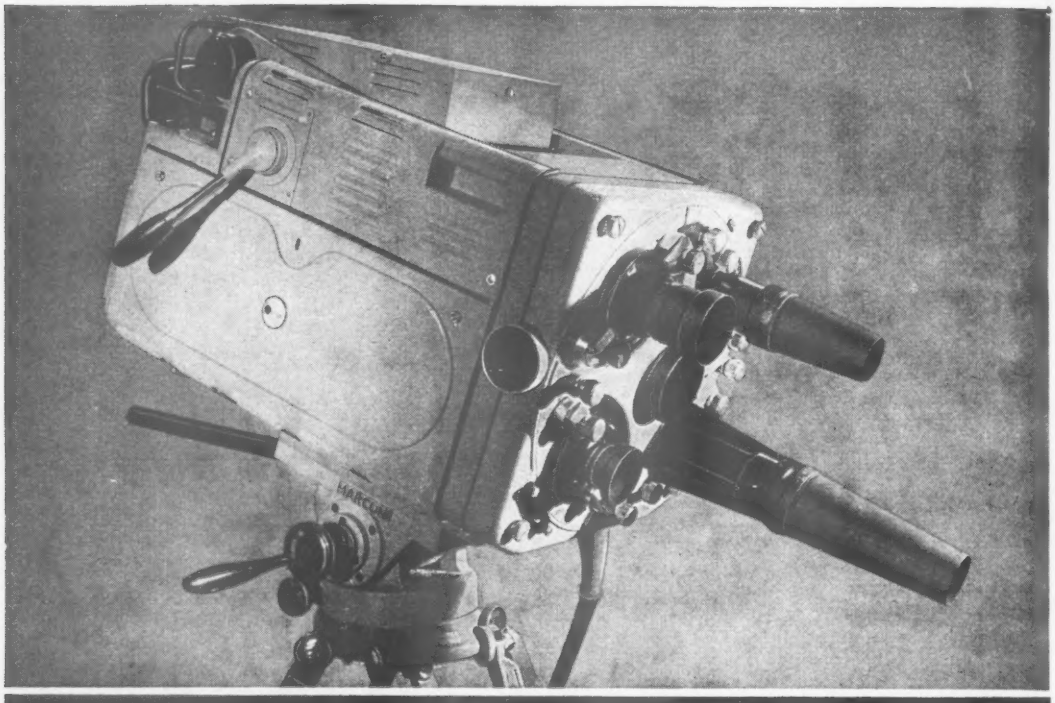

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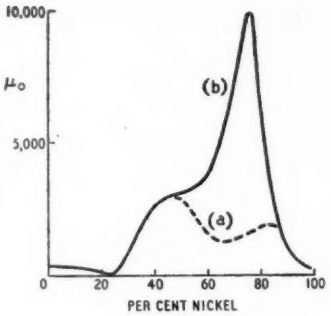


Fig. 19. Variation of initial permeability μ_o with the nickel content of nickel-iron alloys. (a) Slow cooling. (b) Treatment includes rapid cooling from 600°C (from Bozorth).

methods of preparation. They are very widely used, however, in communication engineering where very soft materials are essential. The remarkable properties of these alloys are mainly due to the special considerations discussed shortly, but high purity and freedom from residual strains are again most important. Because nickel-irons are normally required in smaller quantities than the sheet-steels used in power engineering it is possible to adopt more highly specialized techniques in their preparation. The basic metals are obtained in very pure form and melted together in an induction-furnace in a controlled atmosphere or in vacuum. The cast ingots are then subjected to a series of rolling treatments at different temperatures to produce a sheet of the required thickness, which for high-frequency applications may be as little as 0.001 in. The preparation is completed by annealing, usually in hydrogen at a temperature in excess of 1,000°C. The final anneal normally takes place after the strip had been wound into the desired form of core.

The best properties are found in alloys in two composition ranges, those containing about 50% nickel and those containing about 80% nickel. Figs. 19 and 20 illustrate the variation of initial and maximum permeabilities with composition, and show the optimum ranges at about 50% and 80% nickel. In each figure two curves are plotted recording the effect of different heat treatments. The curves (a) correspond to a treatment in which the final process is cooling slowly from a high temperature down to room temperature, while for curves (b) the final process is a rapid cooling from about 600°C to room temperature. Now Bozorth (1953) has measured K and λ for nickel-iron crystals which have been subjected to similar heat treatments. He found that each of the maxima in the permeability curves of Figs. 19 and 20 occur very close to compositions for which the magnetostriction constant *for the "easy" direction* passes through zero. This is precisely what the domain theory predicts. He also found that the magnitude of the anisotropy constant for rapidly cooled 78.5% nickel-iron is considerably smaller than the magnitude of K at each of the other zero-λ compositions, and this clearly explains why the μ_o and μ_m peaks for this alloy are higher than the other subsidiary peaks. The complicated behaviour of the nickel-iron alloys is thus simply related to their basic constants K and λ. The fact that K and λ depend upon heat-treatment seems to contradict the claim that they are "structure-insensitive" constants. In nickel-irons, however, a rather special process takes place in the range of compositions where K and λ are sensitive to heat treatment. At temperatures above 600°C the iron and nickel atoms are randomly distributed in the crystal lattice. If the temperature is reduced the alloys become "ordered", that is each iron atom tends to become surrounded by the same number of atoms of nickel and of iron as every other iron atom. The values of λ and K, and also of I_s and the Curie temperature, depend to some extent on the degree of order. If an alloy is cooled slowly from above 600°C to room temperature ordering occurs but if the cooling is rapid then the random mixing characteristic of the high temperature is "frozen in", and remains.

Commercial development of nickel-iron alloys has been mainly at the two composition ranges 45-50% and 75-80% nickel, and most commercial alloys contain small quantities of other metals. These are added to increase the resistivity over that of the binary alloys and to reduce the sensitivity of the permeabilities to slight variations in heat treatment (by suppressing the ordering process). In some cases the added metals have even markedly improved the magnetic properties, probably because the anisotropy constant K happens to be smaller at the zero-λ composition when they are present. Typical commercial alloys are the Mumetals, containing 72-76% nickel, 5% copper and 2% chromium; Permalloy C containing about 77.4% nickel, 3.7% molybdenum and 5% copper; and, at the lower nickel content, Radiometal with about 50% nickel and 50% iron and Permalloy B containing 50% nickel and 1% manganese.

The high-nickel alloys are useful especially because of their remarkably high initial permeabilities, up to more than 50,000 (though it is difficult to retain the full permeability when fabricating cores). They are employed in thin strip form, for example, in wide-band low signal transformers, in filters, for loading telephone cables, for magnetic screening and in many other devices of the communications industry. Mention must be made of the alloy known as Supermalloy reported in 1947 by Boothby and Bozorth, which is magnetically softer than any other polycrystalline material. Its composition is 79% nickel, 5% molybdenum, 15% iron and 0.5% manganese and by a series of special rolling and heat treatments a material is produced having μ_o as high as 150,000, μ_m over 1,000,000 and H_c about 0.005 oersted. Its hysteresis loss at a peak induction of 5,000 gauss is only 5 ergs/cm³ compared with about 500 ergs/cm³ for silicon-iron and about 50 for ordinary Permalloys and Mumetals.

The low-nickel alloys with 45-50% nickel have

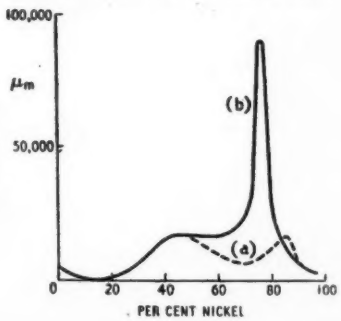


Fig. 20. Variation of maximum permeability μ_m with the nickel content of nickel-iron alloys. (a) Slow cooling. (b) Rapid cooling from 600° C. (from Bozorth).

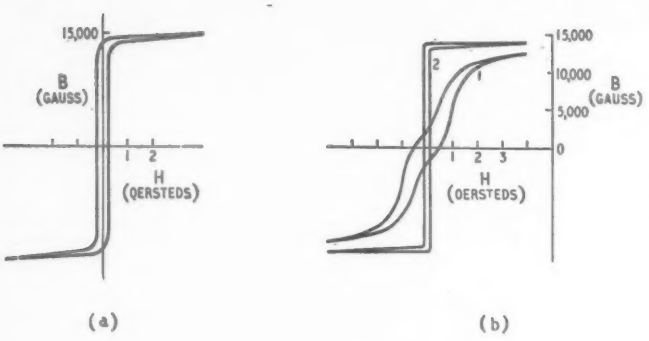


Fig. 21. (a) Hysteresis loop of a grain-oriented 50% nickel-iron alloy. (b) Curves 1 and 2 show respectively the hysteresis loops of 65-Permalloy before and after treatment in a magnetic field (after Bozorth and Dillinger).

smaller initial and maximum permeabilities than the high-nickel group but their saturation inductions are higher (16,000 compared with 6-8,000 gauss) and consequently they have higher permeabilities at high inductions. Their properties are similar to those of the very best quality grain-oriented silicon-iron. They are used for example in small audio-frequency power transformers, and in chokes, relays etc., when a d.c. polarizing current is present, since they have high incremental permeabilities at fields in excess of an oersted or so.

A third group of nickel-iron alloys typified by Rhometal and Permalloy D contain about 36% nickel and find some uses because of their high resistivity (about 90 compared with 45-60 micro-ohm-cm for other nickel-iron alloys and silicon-irons) although they have inferior permeabilities. Eddy current effects are reduced to the extent that their apparent initial permeabilities are almost constant at about 1,000 up to 100 kc/s. when they are in the form of 0.004 in strip, and up to 1 Mc/s. when 0.001 in thick, and they are employed in high-frequency and pulse work.

By appropriate cold-rolling and annealing it is possible to produce a preferred grain orientation in nickel-iron alloys containing between 50 and 70% nickel. As in the grain-oriented silicon-irons the permeabilities at high inductions are thus considerably increased, but in the nickel-irons the type of orientation is such that there are easy directions both parallel to *and perpendicular to* the rolling direction. Grain-orientation is used in the commercial 50% nickel-iron known as H.C.R. This material is almost saturated in fields as low as 0.2 oersted as is to be expected from the domain theory of magnetization in an easy direction. Remanence is high for the same reasons and the hysteresis loop is consequently almost rectangular having nearly vertical sides, as illustrated in Fig. 21(a). Another effect likely to have increasing importance as the demand for rectangular-loop materials grows is *domain-orientation*. It is found that some materials, in particular the 50-80% nickel-irons, respond to the application of a small magnetic field as the material cools during the final annealing operation. The effect is to make the hysteresis loop more rectangular, as shown in Fig. 21(b). Only materials having comparatively high Curie temperatures and rather low anisotropy constants exhibit these effects. Under these conditions when the material cools through its Curie temperature and becomes ferromagnetic the applied field saturates the material and, since the temperature is still high enough for the atoms to be comparatively mobile, some sort of strain relief occurs. When the material has reached room temperature and the field has been switched off the specimen contains only domains magnetized almost parallel to or anti-parallel to the original field direction since, with domains in these directions only, the crystals are in their least strained condition; domains magnetized perpendicularly to the preferred directions would introduce magnetostrictive strain. The detailed nature of the strain relief which occurs during magnetic-cooling is not yet fully understood but the uni-axial nature of the resultant material causes the knee of the magnetization curve and the remanent magnetization to be high, as in the case of a single crystal magnetized in an easy direction. Deltamax, Permalloy F and H.C.R. are materials which are *both* grain- and domain-oriented and applications of their rectangular loop properties are mentioned later.

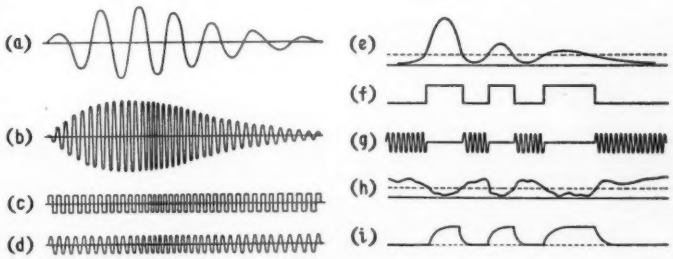
To the long list of commercially available soft magnetic materials there has been added, during recent years, a range of non-metallic materials known as ferrites which have found important applications at radio frequencies, where they compete with powdered iron or nickel-iron as core materials for high Q, loading and filter coils and wide-band high-frequency transformers. The nature of the spontaneous magnetization in the ferrites has been discussed in an earlier section. They are intimate mixtures of iron oxide with oxides of divalent metals such as magnesium, manganese, nickel and cobalt and they have domain structures and behave magnetically like the ferromagnetic metals in most respects. In fact, the magnetism of the ferrites has probably been known for much longer than that of iron metal, because lodestone, the naturally occurring ore which was used for centuries for magnetic compasses, is mostly magnetite, the simplest of the ferrites. The special feature of the ferrites is their high electrical resistivity, and their application, mainly in high-frequency work, is new only because suitable techniques of preparation and fabrication have but recently been developed. The soft ferrites are known commercially in this country as Ferroxcubes and there are two main types, A and B. Ferroxcube A is a manganese-zinc ferrite, that is, an intimate mixture of the oxides of iron, manganese and zinc. It is prepared by carefully mixing the three oxides and grinding them to a fine powder, pressing the mixture in a steel die to the required shape and then firing at between 1,000°C and 1,400°C in a controlled atmosphere. The final product is hard and may be ground to close tolerances. It is not a

bonded powder, but is quite homogeneous. During the firing process the oxides inter-diffuse and the crystals of the final product each contain, within a cubic latice of oxygen atoms, atoms of iron, manganese and zinc. Other ferrites are produced in a similar fashion; Ferroxcube B, for example, is a nickel-zinc ferrite. The d.c. resistivities of the ferrites are from 10^8 to 10^{12} times higher than those of metallic iron, and they are therefore especially suited to high-frequency and pulse applications since eddy current effects are reduced to almost negligible proportions. In metallic cores power loss occurs at high frequencies because eddy currents produce local magnetic fields which slow down the motion of the domain walls. This effect makes itself felt as an apparent drop in the permeability at high frequencies. Even cores made of 0.001-in tape or finely powdered Rhometal exhibit a serious drop in permeability at frequencies above about 100 kc/s. Eddy current damping is almost completely absent in ferrites. Residual damping effects occur in them, due perhaps to changes in the position of impurity atoms as the domain walls move, but they are effective at rather high frequencies. There is a special kind of power loss which assumes importance in ferrites at frequencies higher than 1-1,000 Mc/s, depending on the particular ferrite. This is due to the phenomenon known as natural ferromagnetic resonance. When a spinning electron, which contributes to spontaneous magnetization, is deflected from an easy direction it precesses. That is, its axis of spin rotates about the easy direction just as a gyroscope precesses when disturbed. The precessional frequency is determined by the anisotropy constant K—or by other factors which may, in some materials, determine the easy direction. If a field, which alternates at a frequency close to the precessional frequency, is applied to a specimen, power will be absorbed from the field to provide the precessional energy. This is progressively communicated to the lattice, where it appears as heat. The higher the anisotropy constant K, the higher the frequency at which resonance absorption sets in. On the other hand, as has been pointed out earlier, the higher K the smaller the permeability, whether it be due to wall motion or domain rotation. The magnitudes of K and λ of Ferroxcube B can be varied by adjusting the relative proportions of the nickel and zinc oxides in the initial mix. Ferroxcube B materials have thus been made covering the range of initial susceptibilities from 20 up to 650. The frequencies up to which these materials may usefully be employed in tuned applications range therefore, in the reverse order, from about 100 Mc/s down to 1 Mc/s. Ferroxcube A materials have lower K and λ therefore higher initial permeabilities of about 1,000, but lower limiting frequencies at about 0.5 Mc/s for tuned applications. Compared with the permeabilities of nickel-irons in bulk, ferrite permeabilities are very low, but for the high-frequency applications for which the ferrites are mainly intended, metallic cores would have to be used in finely divided powdered form and then their permeabilities are usually much less than 100. Saturation inductions for Ferroxcubes vary between 2,000 and 4,000 gauss, and their coercivities are between 1 and 5 oersteds. Apart from applications in coils and transformers at radio and video frequencies there are a number of special uses of ferrites especially in microwave or radar techniques. Because they have high electrical resistivities their magnetic-flux-concentrating properties (μ greater than one) can be employed in the construction of aerials which are considerably smaller than conventional types.

(To be concluded)

Technical Notebook

Split-Information Speech transmission system described by F. de Jager and J. A. Greefkes in *Philips Technical Review* Vol. 19, No. 3, is intended for conditions where it is essential to maintain intelligibility at very high noise levels. It is known as "Frena", from the fact that the speech information is split into frequency and amplitude signals, which are transmitted in separate channels then recombined at the receiver. The idea is based on Licklider's experiments on "infinitely clipped" speech waveforms which showed that intelligibility is conveyed mainly by the zero-crossings or frequency information and not so much by the amplitude information. A clipped waveform transmitted at the maximum possible amplitude permits a high noise level without detriment to the frequency information (as in f.m.) while the amplitude component or "envelope" of the speech waveform, being of low frequency, can be transmitted in a narrow bandwidth channel, which, of course, restricts the noise power. In "Frena" the speech waveform (a) is made to modulated a carrier and one of the resultant sidebands (b) is taken for clipping as shown at (c). This gives a finer gradation in displacements of zero crossings than would be obtained by clipping the original a.f. signal and results in better quality. At the same time the envelope of the single-sideband signal (b) is obtained by detection. The frequency signal is transmitted in a 3-kc/s bandwidth, which turns (c) into the almost sinusoidal waveform (d) while the envelope signal is transmitted in a 100-c/s bandwidth. An even greater noise level is permissible if the amplitude signal is coded into an on-off type of switching waveform as shown in the lower diagram. The original envelope (e) is first squared (f) and the intervals are transmitted as short wave trains (g). On reception the signal is deformed by noise (h) but is squared again to receive (f), which is rounded off as at (i) to give a signal for switching on and off the frequency channel at the appropriate instants. This on-off coding has the advantage of suppressing the "packets" of



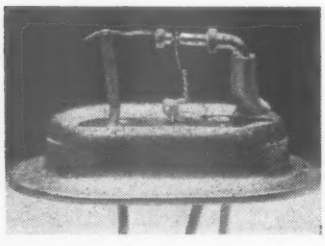
noise which confuse intelligibility by occurring between words or phonemes. It permits a noise power as high as 40% of the signal power, i.e., a signal/noise ratio of only 4dB.

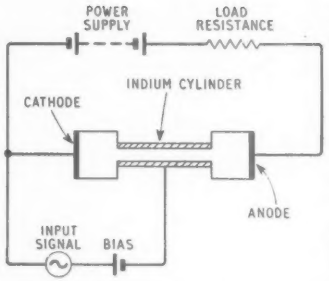
Ferroelectric Switching Devices of the multi-position type are discussed by R. Alonso and T. Conley in D.S.I.R. report PB120239, which deals in general with applications of ferroelectric materials, such as barium titanate, in digital computers.

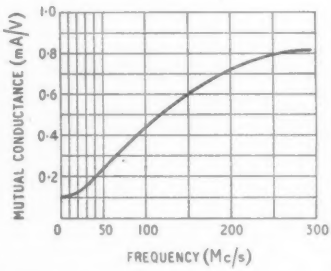
Low-Background G-M Tube with an extremely low rate of count in the absence of the test specimen has been developed by G.E.C. for measuring minute amounts of radioactivity. The length of the anode wire has been kept to a minimum to reduce extraneous response and the materials used have been selected as being free from radioactive contaminants. Background responses as low as 0.4 counts per minute have been obtained using a shielded enclosure and an anti-coincidence system to reduce stray radiation.

Total Differential Feedback.—The amount of negative feedback which can be applied to a multi-stage amplifier is limited by considerations of stability. In multi-channel carrier telephone systems in which the signals pass through many repeaters it is often desirable to apply very large amounts of feedback to keep the total distortion within bounds. A method of squaring the amount of feedback (i.e. increasing it from A dB to 2A dB) without affecting stability margins is described by J. H. C. Davis in the February issue of *Electronic and Radio Engineer*. The signal fed back from the amplifier output is compared with the input signal, and the difference between these (which contains the distortion products) is amplified in a second amplifier and combined with the output of the first so as to cancel the distortion. A useful feature of the arrangement, which is similar to two amplifiers in parallel, is that if one path fails the other remains operative. The gain can be made to remain nearly the same under this condition, though the distortion is increased.

The Tecnetron, the new French v.h.f. semiconductor device mentioned in our February issue (p. 82) is illustrated below. It consists of a

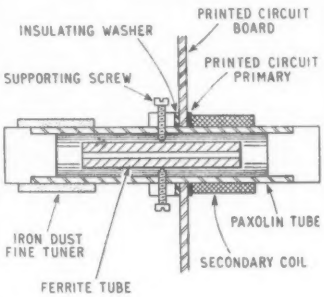






2-mm rod of n-type germanium, 0.5mm in diameter, with a narrow neck in the middle surrounded by a ring of indium. A supply voltage of about 50V sends through the rod a current, which is controlled, as shown in the circuit diagram, by a signal voltage applied to the negatively biased centre electrode. The resultant fluctuations of current then produce an amplified version of the signal voltage across the resistance load. The mechanism of current control is comparable with the field-effect transistor in that a voltage (negative in this case) applied to the indium ring produces an electric field which deflects the current carriers (electrons here) towards the axis of the rod. Thus the conducting cross-section, and hence the resistance of the rod, is varied according to the applied signal voltage. But the device differs from the field-effect transistor in two ways: it does not have an alloyed junction between the centre electrode and the germanium but a surface barrier; and it uses a cylindrical centre electrode instead of two plane electrodes. The importance of the cylindrical structure of the centre electrode is that the variation of conducting cross-section with signal voltage results in a corresponding variation of the capacitance between this conducting region and the indium ring. This effect, in conjunction with the resistance variation which occurs at the same time, is responsible for the Tecnetron's high frequency performance. The anode current/voltage characteristic curves are similar to those of a pentode valve, and in fact the device operates very effectively, like the pentode, as a voltage amplifier. The input resistance is of the order of megohms (capacitance about 0.2pF), while the output impedance is generally greater than 1 MΩ. Mutual conductance increases with frequency as shown in the curve. Experimental results show that a gain of 22dB is obtainable at 110Mc/s or 16dB at 200 Mc/s. As for power output, it is said that 30mW can be achieved in Class A operation at 500 Mc/s.

Printed Filter Coils are used in a novel method of mounting magnetostrictive ferrite filters devised by Cossor Radar and Electronics. Mechanical filters and resonators based on the natural period of vibration of nickel rods, mechanically energized by the magnetostriction effect, have been used for some time and are notable for their high Q and sharp frequency discrimination. More recently ferrite rods have been used in place of nickel to reduce the eddy current losses. The Cossor filter actually consists of a tube of nickel zinc ferrite (see sketch) supported at its centre by three screws symmetrically placed in a brass ring (which is split to avoid the effect of a shorted turn). The input coil for energizing the tube is a single printed turn, while the output coil is an orthodox wire-wound one of 200 turns. An initial permanent magnetic polarization is given to the ferrite tube by passing a large current along a wire passed through its



centre. This circumferential polarization, together with the alternating axial field produced by the input coil, sets up a spiral alternating stress in the tube. If the frequency of the input signal, and hence the spiral stress frequency, coincides with the natural torsional resonant frequency, then the ferrite vibrates and so induces an alternating voltage in the output coil. The bandwidth of a single filter is very small (7c/s), so a whole bank of them is necessary to cover a larger band, and this is where the printed-circuit type of mounting proves useful. A double-sided printed circuit board is used to support the Paxolin tubes containing the ferrite elements. The single-turn primaries, all in series, are printed on one side, while conductors for connecting the output coils to an edge connector are on the other side. Final tuning is by iron dust cores.

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Mechanics of Electronics

PRACTICAL TRANSLATIONS OF CIRCUIT DIAGRAMS; HOUSING THE EQUIPMENT

By W. D. CUSSINS, M.A., Ph.D.(Cantab.)

THERE is a continuous succession of articles in the technical press on useful apparatus for the electronic engineer to make, but hardly ever any details of layout and mechanical design. Nevertheless, attention to these two aspects can make all the difference between an amateurish-looking hookup and a professional instrument. With thought this improvement can be achieved by the use of very little equipment, whilst the extra effort involved pays handsome dividends in the form of improved external appearance, neater, more compact layout and greater accessibility.

The secret of success is a methodical approach.

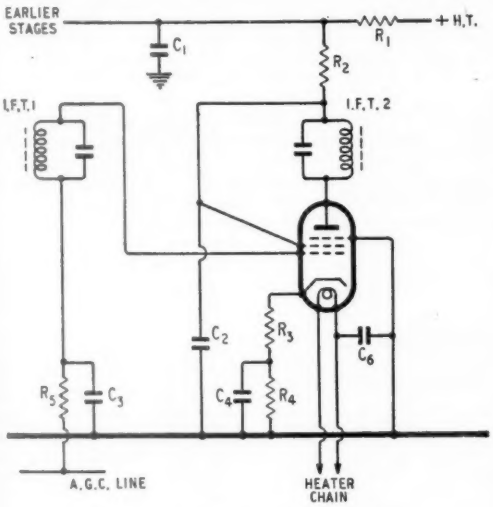

Fig. 1. Circuit diagram of typical i.f. stage.

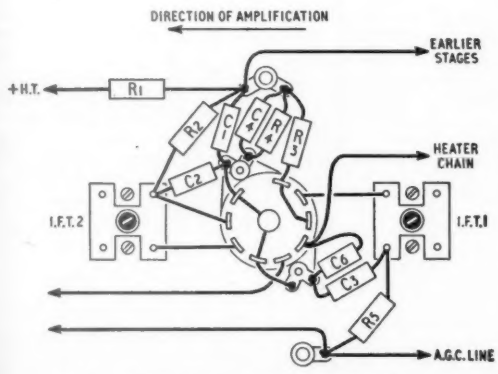

Fig. 2. Practical layout for the circuit in Fig. 1.

It is well worth while keeping a scrap book of ideas; such as component layout, chassis design, external finish, etc. If this is done there is less tendency to take snap decisions about these matters which are later regretted. An idea which appeals when it is recorded in the scrapbook may not appear so good when examined a week later, and after a month may be thrown away because of some overwhelming disadvantage, which only became obvious after a prolonged period of sub-conscious thought.

Thus, when one decides to build a new piece of apparatus, a perusal of the scrapbook will yield a fund of ideas upon which the design can be based. However, before a hand is raised to beat a piece of metal into shape the whole layout should be finalized. This applies not only to the mechanical side but also to the electrical. If this is not possible because the apparatus is to be specially designed, rather than made up from a proved design, it is necessary to make a mock-up to finalize the electrical design before the layout of the apparatus can be decided. It may take longer but the decision to do it will never be regretted.

Component Layout.—It is difficult to give useful generalizations concerning component layout but perhaps details of two entirely different types of circuit layout will provide a few useful ideas.

Fig. 1 shows a generalized i.f. stage, from which most others can be developed by omitting or adding various components. Thus, if a layout can be developed for this it will have a wide application. The main design criterion here is minimum length of leads, even to the detriment of accessibility and ease of construction. They must not suffer unnecessarily and Fig. 2 shows a reasonable compromise which has proved quite satisfactory in practice. Care has been taken to orientate the valve holder to give the shortest possible leads into the coil cans. The heater leads, h.t. and a.g.c. lines are all arranged so that they will easily link up with previous and later stages.

A completely different type of circuit is illustrated in Fig. 3. It is the driver and output stage of a push-pull amplifier, drawn somewhat unconventionally in order to show up its electrical symmetry. This obviously cries out for imaginative treatment when it comes to layout. In this type of circuit there is usually sufficient space to lay out the components on tag-strip screwed to the chassis under the iron-cored components. A little study results in the layout shown in Fig. 4. It is neat, makes all components accessible and enables the circuitry to be followed easily.

A third type of layout was developed for the

detector, noise limiter and audio stages of a television receiver. In a television set, chassis area is at a premium, but there is usually plenty of space to build component panels at right angles to it. A tag-board as shown in Fig. 5 can be used. This type of board is very useful for all electronic circuitry where there is a high density of components. For instance, one long board was used to carry all the components necessary for the video, sync-separator and both time-bases of a television receiver except the pre-set and iron-cored ones.

These basic layouts have been used for all apparatus built by the author in the past few years and have proved highly satisfactory. Other people may prefer variations but the basic idea of planned component layout is very important and saves a great deal of time when fault finding.

Mechanical Design.—Having suggested various methods of laying out the components in a piece of equipment let us see how the chassis to hold them can best be designed and built. But first of all let us digress to see what tools will be required over and above the normal mechanical workshop selection. There are two essentials for a neat job: a guillotine and a bender. Small versions of each can be bought quite cheaply and over the years will pay for themselves many times. A third, which is essential to the person who does a lot of work, is a universal bolster press with a varied selection of punches (circular and rectangular) and a louvre tool. A cheap alternative to this is a hand-operated lever punch, which will make holes up to ½in diameter, and a set of chassis cutters. The great advantage of punches over drills is that they produce clean holes without burrs. Using these tools and your ingenuity it is possible to work near miracles.

And now to the chassis itself. The first thing to remember is the size of the sheet of metal from which it will be cut. It is possible to get many more pieces 17½in wide than 19in wide from a 3-ft wide sheet. Make sure, therefore, that the design will cut economically from the available sheets. Forget about the beautiful effects manufacturers get with their expensive press tools and try to imagine how near it is possible to get with a bender. By way of illustration consider the box for the portable amplifier (Fig. 6) and the rack (Fig. 8) and power amplifier chassis (Fig. 9) for mounting in it.

The portable amplifier box was made in five parts as shown, the two ends being identical. The top slides inside the vertical lips of the ends, but rests on the horizontal ones. To allow this to occur the ends are notched as in Fig. 7 (a) so that when the sheet is bent along the dotted line the result is as shown in Fig. 7 (c). If a press tool is not available to notch the corners it can be done neatly by first drilling a small hole and then cutting with a pair of tin snips (see Fig. 7 (b)). Cutting the corners farther back than the bend lines is necessary to allow the top to pass through the slot, but it is a useful dodge to adopt at all times to enhance the appearance of the closed box. Another application of the same principle is shown in Figs. 7(d) and 7(e). The ends were attached to the main chassis with a ⅛-in clearance. The advantage of this is threefold. There is an inevitable bend radius of the end lips which prevents the lip and chassis sides from lying flat unless the spacing exists. It allows the top, which is the same width as the chassis, to slide easily into position. It also leaves slots into which the lips on the bottom fit. These latter are multi-purpose; stiffening the bottom, giving it a smooth surface (note the ends do not project as far down as the lower edge of the chassis) and preventing the ends from bowing inwards. This box is very easy to construct and very strong when made. However, before attempting to make one, try a few sample bends with the sheet metal you are to use to get an idea of the allowance to be made for bend radius. Do not forget the thickness of the metal in your calculations.

Now to something rather more ambitious; or so it would appear at first sight, namely, the rack. The framework is of 1½in × ⅛in angle iron, with

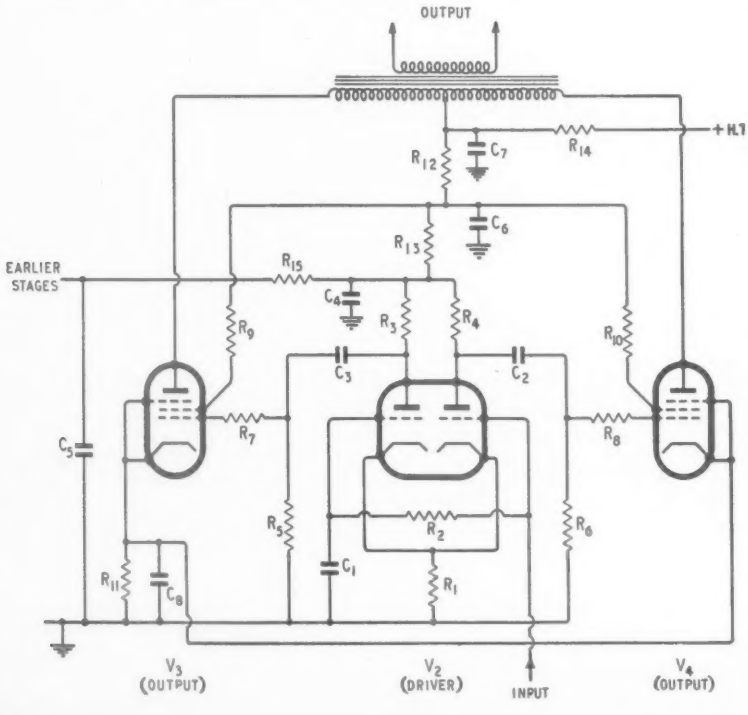

Fig. 3. Driver and push-pull output stages drawn to emphasize the symmetry of the circuit.

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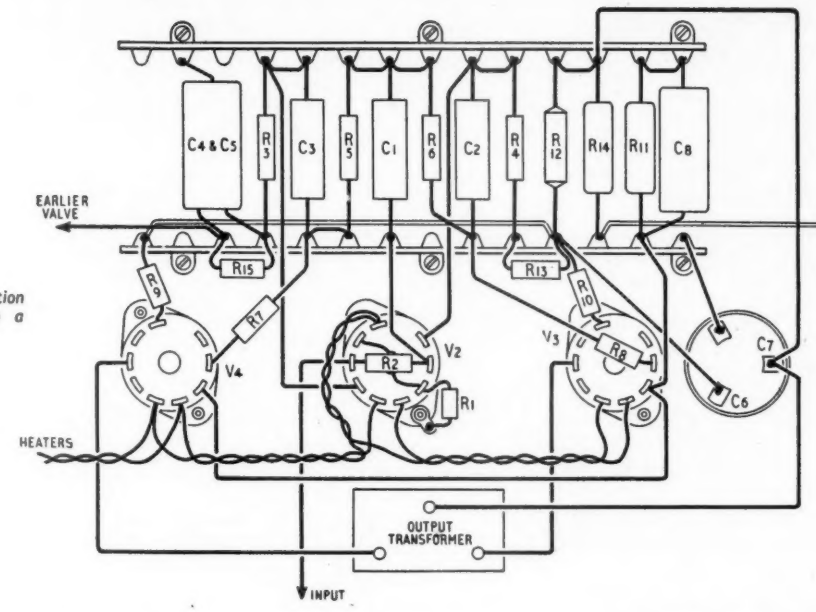


Fig. 4. Translation of Fig. 3 into a practical form.

some rather more substantial channel-section for feet. All the pieces are cut to size and shape and then electrically welded together. In the absence of a welding plant, there are plenty of small engineering firms who will do it quite cheaply, as it is a very speedy process. The side and top covers are designed so that there is adequate ventilation through holes in the cover plates. With the framework painted black and the cover plates and front panels stove-enamelled grey the result is very impressive but, in fact, very little equipment was involved in making it. The power amplifier chassis (Fig. 9) shows how a quite complicated shape is built up from simple pieces. In cases like this, decide what is the best chassis layout and then try to imagine how it can be constructed, using the tools at your disposal.

The amateur's favourite method of joining chassis parts together is to use nuts and bolts. Their use, however, is to be discouraged. For things which are to be permanently connected, riveting is far better and cheaper. A little practice in the use of aluminium rivets will soon lead to proficiency. An alternative is to use self-tapping screws, which can also be used in positions where they may occasionally have to be removed. Where screws are necessary, it is preferable to use tapped holes or captive nuts with them.

If more than one-off is desired, it is necessary to make a template and mark off from that. This is best done by cutting the template to size and marking the positions of all the holes and bends on it. Then drill small holes at all these points, place the blanks underneath and centre-punch through. This is best done on a marking-out board consisting of a sheet of plywood with two strips of angle iron screwed to it at right angles. If only three or four are required, the template can be made from the same material as the chassis and when the latter have been centre-punched they can all be turned into finished articles. For larger numbers a piece of high-grade sheet steel about 20 gauge is preferable.

Finish.—To conceive and construct a small masterpiece of electronic equipment is insufficient unless attention is paid to external finish. This adds little to the cost, but greatly to the appeal. Remember, friends will see only the outside and make their

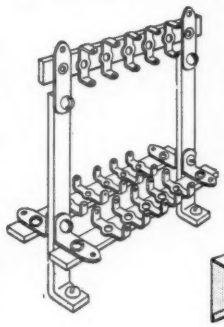


Fig. 5. Group-board assembly for mounting components vertical to the chassis.

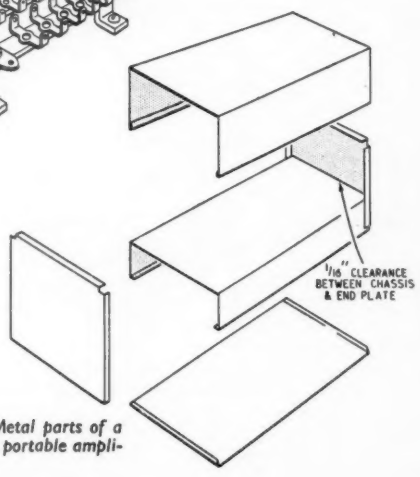


Fig. 6. Metal parts of a box for a portable amplifier.

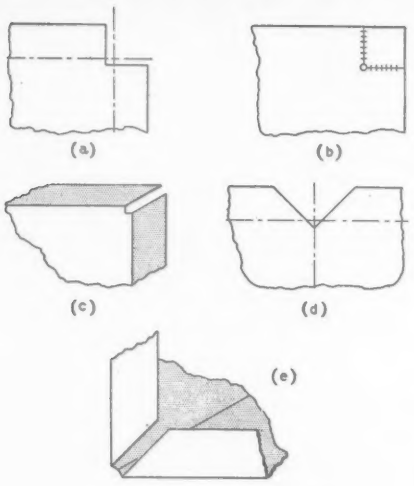


Fig. 7. Details of the corners of the box shown in Fig. 6.

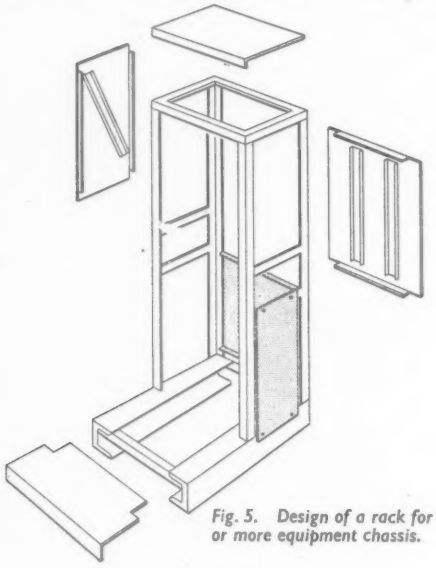


Fig. 5. Design of a rack for two or more equipment chassis.

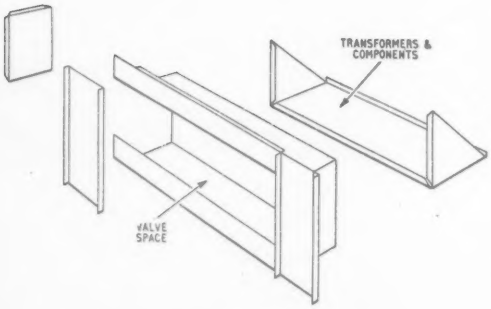


Fig. 9. Details of a power amplifier chassis.

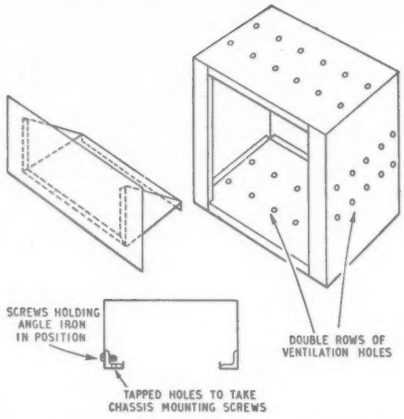


Fig. 10. Metal cabinet for housing two equipment chassis one above the other.

judgments therefrom. Bare metal and stuck-on bits of paper are taboo. It is not difficult to get the external surfaces cellulose sprayed or even stove enamelled, and several types of transfer are readily available.

For really special pieces of gear, lettering can be engraved instead of transferred and chromium-plated handles and screws used. It is, of course, possible to buy professionally made cabinets or kits, but to use them is almost an admission of defeat by the proud engineer. Here, again, a scrapbook or folder of pamphlets of these odds and ends is very useful, otherwise when something is required, although you know an item is available, you cannot remember who supplies it.

Up to now most, if not all, of the suggestions for improving the breed have involved extra expenditure, and unless economies can be made in other directions, no one is likely to heed them. The obvious one is in the purchase of materials.

As with all stores, the ideal is to achieve the maximum usefulness with the minimum of stock. This means standardization and has the advantage that, with less choice, it is easier to choose. Let us examine a few ways in which this can be achieved. Keep the gauges of metal used down to a minimum; say two, one for chassis, the other for front panels. So far as screws are concerned, standardize on one type of head (cheese head is suggested as being the most useful), the usual even-numbered B.A. sizes and a minimum number of lengths. Most types of valve are now produced with a B9A base, so use this whenever possible. Make sure that all resistors of a particular wattage are of the same appearance and similarly with capacitors. Nothing looks more amateurish than a mixture of different resistors, ceramic, insulated and uninsulated with radial or axial wire ends.

The same ideas should also be applied to the boxes in which the equipment is housed. Almost every piece of gear consists basically of two parts, a power pack and the main equipment. Power packs take much the same form and to a large extent are interchangeable; so why not use a cabinet which will take two chassis connected by a multi-wire cable, one containing the power pack, the

other the specialized item of electronic equipment.

This has the advantage that several containers (and power packs) can be made at a time, which is much quicker than making a succession of one-offs. A simple practical layout is shown in Fig. 10. The box consists of a single sheet of aluminium bent as illustrated with angle-iron screwed in position down the sides (this is then drilled and tapped along the front edge to act as screw fixing for the chassis). The top and bottom, which are identical, are then screwed into position and it is now ready to house the two chassis. Ventilation holes and rubber feet are added as desired.

Standardization can also be applied to the circuitry adopted. Consider, for example, the audio engineer who is called upon to build a succession of specialized equipments. All of them will probably contain a tone control network and a low-noise level microphone stage. Suitable circuitry can be developed for each purpose and then used on all possible occasions. This saves time in design and promotes reliability. To chop and change designs every time a new development is announced is foolhardy. Note them, study their pros and cons, but do not incorporate them in any permanent apparatus until a mock-up has proved their substantial advantage over the "old faithful."

Summary.—This article has attempted to show how, with a few extra tools and a lot of ingenuity, the standard of mechanical design by the amateur and semi-professional electronic engineer can be improved. Appearance, layout and accessibility are important factors in all apparatus and a little time spent in considering them initially will be amply repaid during the gear's life. Do not be afraid to copy the professional, but branch out and be original if, after consideration, circumstances warrant a new approach.

Suppressing Television "Bright Spot"

Inexpensive System for Protecting Receiver Screens

By E. MOSTON KENNY*

A DISTURBING feature of many television receivers is the intense stationary spot which appears on the tube immediately after switching off the receiver. Apart from the visual annoyance, the continued application of this intense spot to the same position on the tube can subsequently result in an ion burn on the screen.

The fact that a spot remains on the tube after switching off is due to: (a) the almost immediate collapse of the scanning circuits when the h.t. is switched off, and (b) the discharge time of the tube capacitance or e.h.t. capacitors. As e.h.t. is available for the anode of the tube, and its heater is still warm, electron emission continues, producing an unscanned beam.

Various methods can be used to suppress or deflect the bright spot. One of them is a special brilliance control now available† which suppresses the bright spot at the moment of switching off, the essential feature of the scheme being that the brilliance control should operate the "on/off" switch of the receiver.

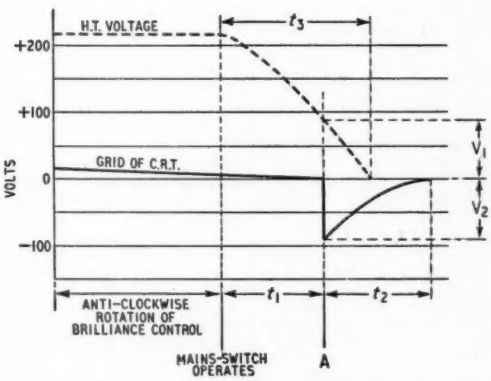


Fig. 2. Voltage on the grid of the c.r. tube as the brilliance/on-off control is turned off.

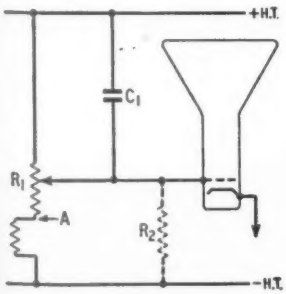
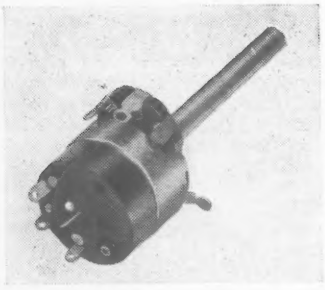


Fig. 1. Suppression circuit using the new brilliance control.

The principle of operation is as follows. Referring to Fig. 1, R_1 is the brilliance control. In the process of switching off, the slider is brought towards h.t. negative, reducing the brilliance of the tube. At point A, the "on/off" switch is turned "off" and a short interval of time afterwards the slider becomes open circuit to the resistance track. At that moment the grid of the tube is swung negatively and as a result the bright spot is suppressed.

Referring now to Fig. 2, the voltage applied to

* Morganite Resistors, Ltd.
† Morganite type ABS control. Patent Application No. 10259/57.



The new combined brilliance control and on-off switch.

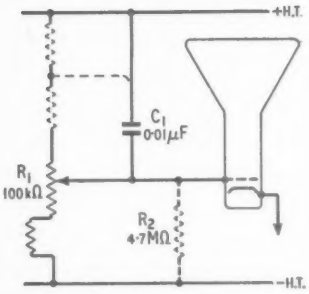


Fig. 3. Practical form of Fig. 1 with circuit values.

the grid of the c.r. tube is shown by the heavy line and the main h.t. voltage by the broken line. On switching off, the main h.t. commences to decay over a period of time t_3, but at a point some time after the commencement of this period the bottom end of C_1 becomes open circuit. By virtue of opposite charge this point swings negative to a voltage (V_2) equal to the h.t. decay voltage (V_1) but opposite in polarity, thereby cutting off the tube grid. The receiver is now in the "off" position, and the grid of the tube will slowly return to zero volts (h.t. negative) on a time constant (t_2) controlled by C_1 and R_2. As the receiver should not normally be switched on immediately after switching off, the time t_2 can be of the order of minutes. R_2 (if fitted) should be fairly high, of the order of five or ten times R_1.

A practical circuit is shown in Fig. 3. The values are suitable for an h.t. supply with a decay time of 0.5 seconds. The negative voltage applied to the grid of the c.r. tube can be reduced, if required, by taking the h.t. end of C_1 to a lower point on the potential divider chain as shown by the dotted connection.

B.B.C. STATISTICS

AS always, the "B.B.C. Handbook"* is a veritable mine of information on the organization and administration of the Corporation's sound and television services. The following few facts and figures have been culled from the 1958 Handbook.

Although the v.h.f. sound broadcasting service now covers over 84 per cent of the population and will increase to 96 per cent by the end of 1958, there were only three-quarters of a million v.h.f. sets in use last autumn.

There are still some 16 million adults in the United Kingdom without television receivers.

Of the B.B.C.'s staff of 15,242, 4,200 are engaged exclusively on work for the television service and 3,250 on technical engineering duties.

Seventy-five per cent of all B.B.C. recordings are now on tape.

Crediting £2 from each £3 combined sound and television licence to the television service, and proportioning the Treasury and Post Office deductions *pro rata*, the income from licences in the year ended last March was as follows. (The additional £1 excise duty on television licences is also retained by the Treasury.)

	Sound	Television	Total
B.B.C.	12,115,948	11,674,260	23,790,208
Treasury	1,400,117	1,349,883	2,750,000
Post Office	974,626	939,658	1,914,284
Gross licence revenue ...	£14,490,691	£13,963,801	£28,454,492

Of the £9.1M spent in operating the television service, £4.3M was on programmes and £3.5M on engineering. Of the £11.6M on sound broadcasting, £6.3M was spent on programmes and £2.7M on engineering.

Rental paid to the Post Office for lines during the year ended last March totalled over £1M. Two-thirds of this was for links for the television service.

The cost of the television service increased by 21.7 per cent. The cost per hour of transmitting programmes rose from £2,675 to £3,256. Home sound services increased by 6.5 per cent to £575 per hour.

Total number of programme hours in the Home sound services for the year covered by the Handbook was 20,120, a slight decrease on the previous year. Transmission time in the television service increased by 165 hours to 2,794 hours, and in the external services by 506 hours to 29,561 hours.

* "B.B.C. Handbook, 1958," 288 pages, 5s.

TV Tower Tests

TESTS using reaction-type rockets were carried out recently on the completed Crystal Palace television tower in order to find its natural frequency of vibration and the structure's capacity for damping out such vibration. Air flow within a certain range of wind speeds can incite rhythmic lateral movement of a structure of this kind causing it to deflect as a vertical cantilever. Should this motion coincide with the natural frequency of vibration of the structure, or its harmonics, and the controlled damping be inadequate, it could lead to the complete collapse of the tower.

A total lateral thrust of about 2.14 tons was applied to the 450-ton tower by firing 6 rockets fixed at the 630-ft level and this produced an oscillation of 8in each side of the vertical.

Instrument recordings are being analysed by the N.P.L. and it is expected that the results of the tests, believed to be the first of their kind on a high tower, will prove of great value not only in the study of the Crystal Palace's tower reaction to wind forces, but also in the design of similar structures.

B. I. Callender's Construction Co., who designed and built this 708-ft self-supporting tower, have produced an interesting film called "The Phœnix Tower." It traces the design and construction of the tower from the site excavation through the varying processes in the works and during erection to the installation of the u.h.f. experimental aerial which surmounts it. The 40-minute film, which incidentally does not include any shots of the tests referred to above, can be borrowed from B.I.C.C., 30 Leicester Square, London, W.C.2.

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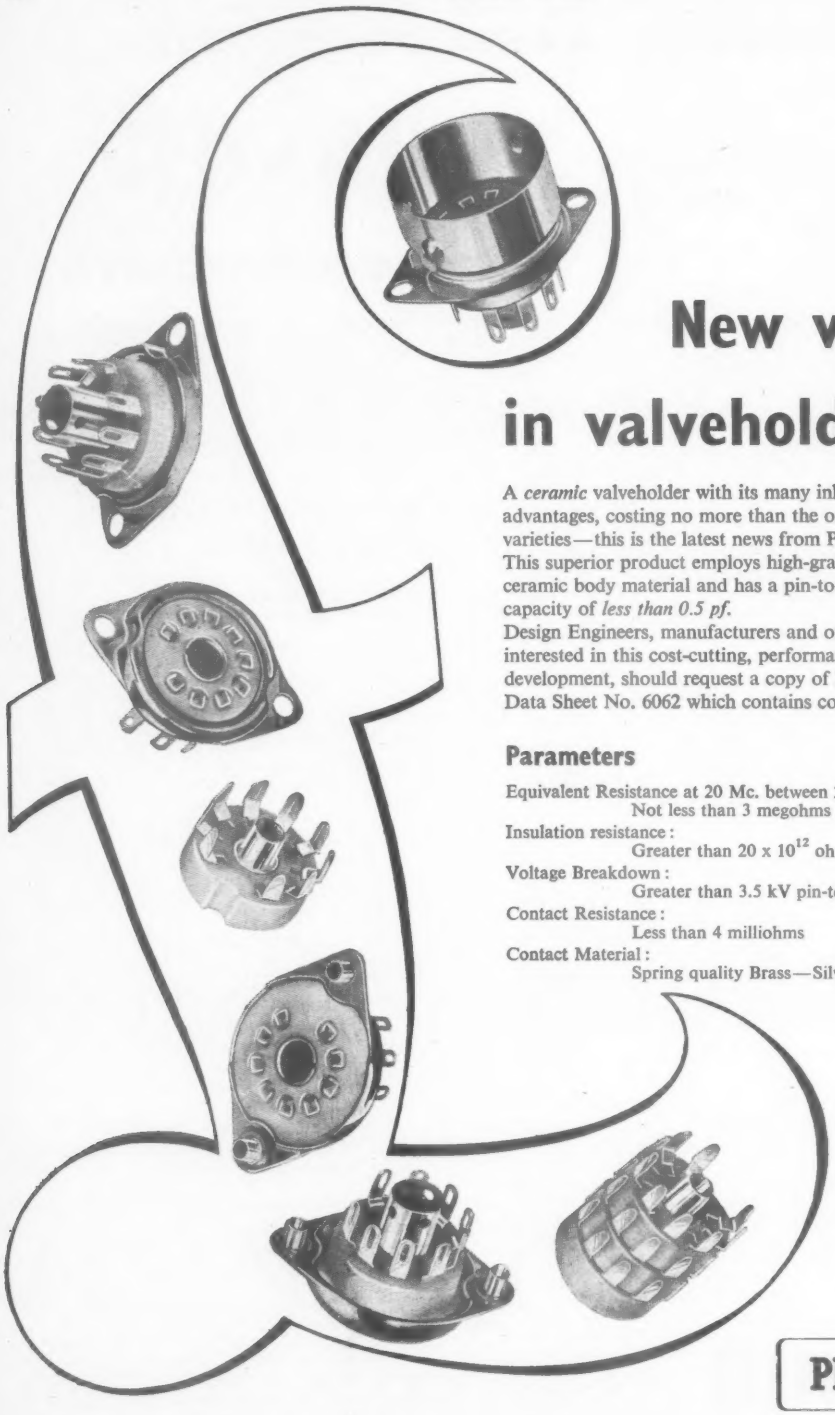

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A *ceramic* valveholder with its many inherent advantages, costing no more than the ordinary moulded varieties—this is the latest news from Plessey at Towcester. This superior product employs high-grade, low-loss ceramic body material and has a pin-to-pin capacity of *less than 0.5 pf.*
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Insulation resistance:
Greater than 20 x 10^{12} ohms
Voltage Breakdown:
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Contact Resistance:
Less than 4 milliohms
Contact Material:
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Forward Projection in the Home

Converting a Rear-Projection Television Chassis

By A. G. TUCKER

FOR various reasons projection television for the home has not been a success, either here or in the United States. When manufacturers were faced with the demand for bigger pictures a few tentatively tried some rear-projection models, but gradually the trend has swung over to larger and larger cathode-ray tubes for direct viewing. To-day there are only a few projection models available for home use, and I believe all of these are rear-projection types.

The objections which have been raised against this type of receiver may be summarized as follows:—

(1) An insufficiently brilliant picture, necessitating viewing in a nearly dark room.

(2) In the case of forward projection, a large and unwieldy console standing in the centre of the room, with mains and aerial leads lying across the floor.

(3) Rather poor e.h.t. regulation, with consequent focus instability with changing picture content.

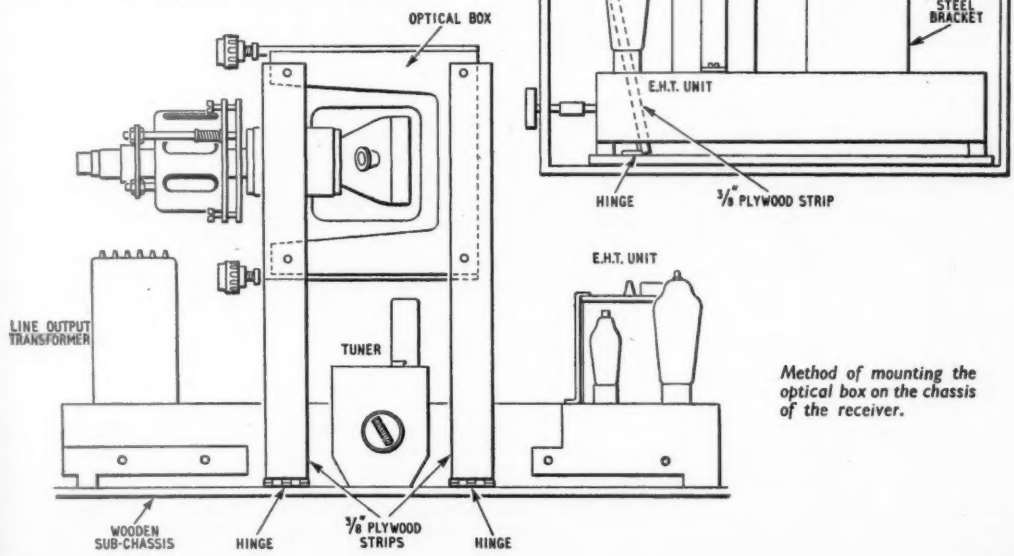
(4) Complicated circuitry and less reliability.

It is the purpose of this article to show that all these objections can be overcome, partly or wholly, in the case of forward projection in a normal-sized living room.

Dealing with the objections in order, first of all it must be remembered that nearly all commercial forward-projection receivers are designed specifically for use in schools, hospitals, etc., where an audience of perhaps thirty or forty people has to be catered for. This necessitates a large, sometimes flat screen, usually 4ft × 3ft, situated fairly high on the wall—a position which will give maximum reflection of any ambient lighting in the room.

At home a different procedure may be adopted. In the writer's case the screen is mounted in a wooden framework which gives adjustable height and tilt. The centre of the screen is only 26in from the floor and it is tilted at about 10° from the vertical. The screen size of 30in × 22in is considerably larger than the largest direct-view picture obtainable, and is just about optimum for the room size of 14ft × 12ft.

The room lighting for normal viewing at present consists of three 100-watt lamps reflecting from the ceiling. This gives adequate illumination, at the same time permitting a reasonably good picture to be enjoyed. On special occasions—for example, when the family wishes to sit down and enjoy a



Method of mounting the optical box on the chassis of the receiver.

Arrangement of the modified projection set and screen in the author's living-room.

good play—a small standard lamp is used, when the performance can only be compared with a good cinema picture. By making the screen slightly concave in a horizontal direction a wide angle of viewing is obtained, and its forward tilt and low position give minimum reflection of ambient lighting. Activated aluminium screens of similar design may be obtained from P.A.M., Ltd., of Guildford, Surrey.

Compact Console

Coming now to objection (2), it is quite possible to make a forward projection console reasonably small. The particular one in use by the writer at the moment is built around a Philips 704A chassis and measures only 15in high by 21in wide by 18in front to back. By fitting the optical box at the rear of the chassis, i.e., farthest from the screen, the console itself is brought nearer to the screen and farther from the centre of the room. The main reason for making the console as low as possible is to enable the picture to be viewed from normal armchair height over the top of it, i.e., directly in front of the screen where the picture is at its brightest. In its position about 5ft from the screen (64in from the corrector plate to screen) the console also comes in useful as a coffee table.

The best way to overcome the difficulty of untidy leads is to run aerial, mains and speaker leads in one piece of sleeving from the console to two sockets on the skirting board near the screen—one for mains and one from the aerial and speaker. It will be found far better to place the loudspeaker with the screen rather than in the console, partly to avoid the "disembodied voice" effect and partly to save precious space in the console. Two leads have to be run to the console anyway, so that the extra leads for the speaker are no problem.

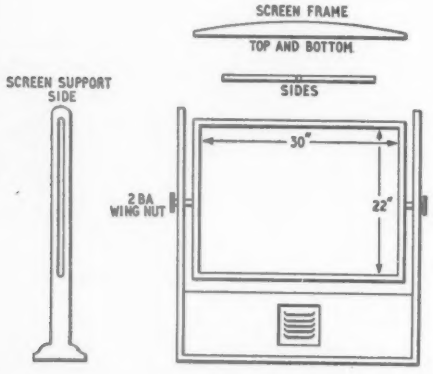
With regard to objection (3), this problem solves itself to a certain extent with forward projection. Owing to the greater light transfer efficiency as compared with rear projection, the beam current of the c.r.t. need not be so high for a bright picture and consequently the e.h.t. generator need not be driven so hard. The regulation of any of the commercial rear-projection models will usually be quite adequate, but should greater focus stability be desired there are various ways of doing this which should be well within the ingenuity of *Wireless World* readers. One solution is to introduce a certain amount of vision a.g.c. which is based on the peak white in the picture. This degrades the contrast values to a certain extent but gives a good stable picture.

The fourth objection, of complicated circuitry and unreliability, is simply not true. The only additions in a projection receiver are the e.h.t. generator and a safety circuit which blacks out the beam to prevent burning of the screen if either timebase should fail. In the writer's experience these sets give very little trouble and when they do the servicing is usually straightforward.

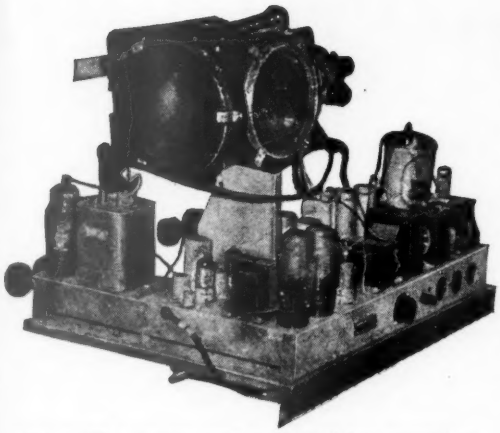
At the present time there are many old rear-projection sets on the second-hand market and the only major modification necessary for conversion to forward projection is the changing of the corrector plate on the Mullard optical box to give a throw of 64 inches. I understand that this service can now be done through any Philips dealer by M. Bender (Northern), Ltd., of Newcastle-upon-Tyne.

It is hardly possible to give detailed instructions for the mounting of the optical box as this will depend entirely on the particular chassis chosen for conversion. From the point of view of ease of servicing and initial setting-up, etc., it will be found better to mount the box directly on the chassis rather than fix it to the interior of the cabinet. It must be rigid and have some means of varying the angle of throw in a vertical direction through about 5-10°.

The Philips series 600A, 1800A and 704A receivers, being very compact, are particularly suitable for conversion, and in these the optical box may be mounted approximately in its original position, i.e., next to the e.h.t. unit. Two pieces of $\frac{3}{8}$in plywood $1\frac{1}{4}$in wide by 12in long are bolted to the back of the box and have their lower ends joined to the wooden sub-chassis by hinges. The front of the box is bolted to two steel brackets fitted to the main chassis at right angles to the box. The



Constructional details of the screen with the loudspeaker built in below.



The modified receiver with the optical box mounted on the chassis.

bolts connecting the box to these brackets run into slots in the brackets to allow the vertical angle to be varied. Incidentally, with this method of mounting it will be found that a turret tuner will just fit under the box, with its station selector knob nicely in line with the other controls. It must also be remembered that these chassis are live, and suitable precautions should be taken to ensure that no part of the chassis is accessible from outside the cabinet.

It does not come within the scope of this article to deal with circuitry but merely to give suggestions for the general arrangement of the console and screen for home use. If these suggestions are carried out I can promise that the result will be a pleasant surprise, especially to those who have only seen forward projection at exhibitions or in shops. In spite of the fact that, in theory, it is impossible to obtain a real black on a silver screen in a lighted room†, it will be found in practice that the contrast range is at least as good as a direct-view receiver. This is probably because black is only comparative in any television receiver and the extremely good highlights obtained on the silver screen make the blacks appear just that much blacker.

Better Picture Quality

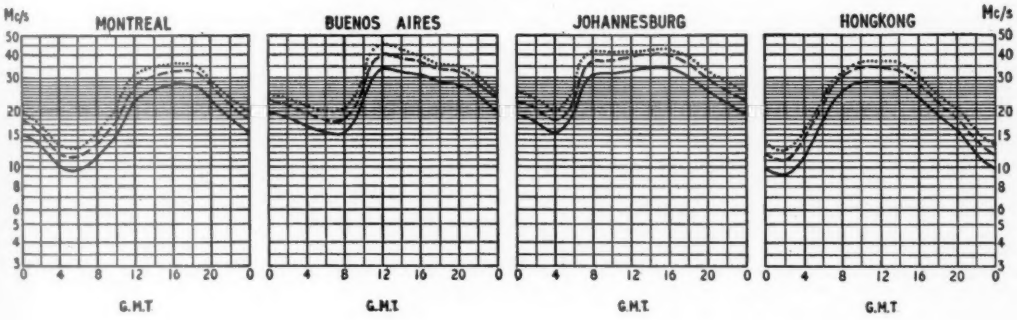
One of the main criticisms of back projection has been the "softness" associated with this type of picture. This effect is mainly due to the light scattering which cannot be avoided with even the thinnest of translucent screens but which does not occur with forward projection, where the light is beamed directly on to an opaque screen. The absence of external mirrors, which slowly lose their efficiency through the accumulation of dust, etc., is another great advantage over rear projection. It would probably be fair to say that the general tone or "goodness" of the forward-projection picture lies somewhere between that of a good rear-projection set and that of a direct-view type, with a bias toward the last-mentioned. When one considers the many other advantages of forward projection, e.g., the really big picture and the beautifully even focus, the change is certainly worth considering.

In conclusion, not the least of the advantages of forward projection is the low cost of replacing the c.r.t., which is only about one-third of the price of even a 21-in direct-view tube, and unless I have been exceptionally lucky the useful life of these projection tubes is, if anything, longer than that of their big brothers.

† "Projection Television," Letters to the Editor, December, 1957, issue.

SHORT-WAVE CONDITIONS

Prediction for March



THE full curves given here indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long-distance paths from this country during March.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

..... FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE FOR 25% OF THE TOTAL TIME

— — — PREDICTED AVERAGE MAXIMUM USABLE FREQUENCY

——— FREQUENCY BELOW WHICH COMMUNICATION SHOULD BE POSSIBLE ON ALL UNDISTURBED DAYS

The Magnetodynamic Pickup

Advantages of a Moving Magnet System

By C. BROWN

SOME of the most successful gramophone pickups to appear in recent years have used the electrodynamic or moving-coil principle and at least two have employed a cantilever type stylus, the advantages of which are well known. In the electrodynamic system, however, a coil of extremely fine wire with only a few turns must be used to ensure that the mass of the moving system is kept low. Even with a large magnet, the voltage induced in such a pickup is very small and a transformer is required between the pickup and any practical amplifier.

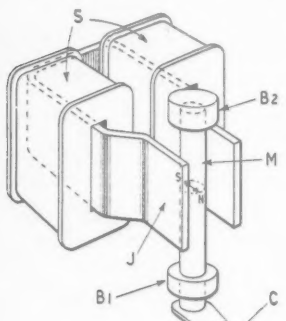


Fig. 1. Principle of the magnetodynamic pickup.

In the magnetodynamic pickup developed by Philips, the magnet and coil exchange their roles: the magnet is the moving element and the coil is fixed. A much higher sensitivity is possible than is the case with the electrodynamic system and no input transformer is needed.

The magnetic system of this pickup differs also from that employed in moving-iron (variable reluctance) pickups: in these, a part of the magnetic circuit moves, but not the magnet itself.

Design Details.—A rod-shaped permanent magnet M is located between the ends of a yoke J in which the coils S are wound (Fig. 1). This rod armature is diametrically magnetized and is held in two bushes B_1 and B_2. At the lower end, the magnet has a needle arm or cantilever C cleated to it with an aluminium collar, and the diamond tip D is fixed in a similar fashion.

The equilibrium position of the magnet coincides approximately with the position of magnetic symmetry and, clearly, any lateral movements of the stylus will produce flux alternations through the yoke and hence induce a signal voltage in the coils.

Sensitivity is high (approximately 44 mV per cm/sec) giving an output of 24 mV r.m.s. for a peak velocity of 6 cm/sec—a typical value for microgroove records. This figure, although lower than for crystal pickups, is higher than can be achieved with many electrodynamic movements using transformers. It is higher, too, than that of many pickups of the variable reluctance type.

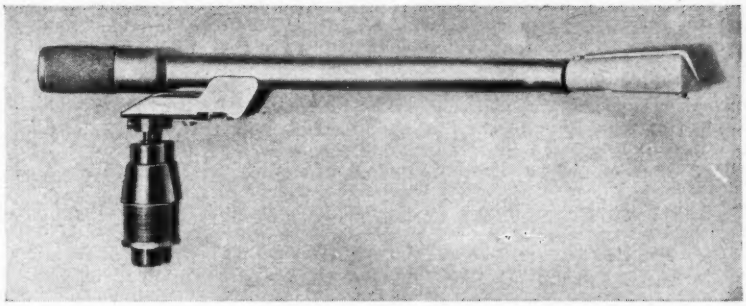
The Moving System.—The component parts of the pickup "cartridge" are shown in Fig. 2. The most unusual of these is the magnet, and some comment on the choice of material and shape may be of interest.

To achieve good sensitivity, the magnet flux must have as high a value as possible. The magnet should be proof against demagnetization by external fields; this necessitates a high demagnetization factor, and a "short" magnet is therefore called for. A further essential, in view of the high accelerations which will be encountered, is a small moment of inertia.

A magnet to satisfy these requirements was made possible by the development of Ferroxdure[1], a material with a high coercive force—about 1,000 oersteds in the present application. The density is low: about 4,000 kgm/m^3, compared with twice this figure for Ticonal steel. The conflicting requirements of large flux and small moment of inertia were resolved in a rod shape, 0.8 mm in diameter and with an effective length of 8 mm. The effective mass at the stylus is 2.8 mgm. The rod is made by extrusion, sintering and grinding, and is magnetized perpendicular to its axis of rotation.

Fig. 2. Component parts of the pickup. (Left to right) Yoke and coils; magnet and stylus; rubber and p.v.c. bushes; polyester block, cast around the yoke and coils; complete "cartridge". On either side of the cantilever are protecting shoulders.

This form of armature is obviously a much simpler manufacturing proposition than the electrodynamic pickup's coil of fine wire on a fragile former; it is more reliable in service and there is great consistency in performance between large numbers of pickups. Accurately dimensioned rod magnets are obtained which are easily interchangeable.



Complete pickup and arm, showing "micrometer" adjustment of playing weight.

The restoring couple for the magnet is provided by the rubber bush B_2 in Fig. 1. Damping must also be provided and this is achieved over a wide frequency range by the p.v.c. bush B_1. This damping, the effective mass and the stiffness of the movement, comprise the mechanical impedance. The bore of the p.v.c. bush is slightly greater than the magnet diameter; the magnet is pulled against the wall of the bush during use and this is found to give a suitable degree of damping. The lateral compliance obtained with this arrangement of bushes is at least 5×10^{-6} cm/dyne.

The method of supporting the armature permits movement other than rotation. In an electrodynamic system this could lead to the generation of unwanted signal voltages; at the same time it has often been found that too great a restriction on movement is liable to provoke distortion due to the introduction of resonances into the audible frequency range. In the magnetodynamic system, therefore, where in theory only one mode of armature movement can produce a signal voltage, there is an advantage in allowing freedom in more than one direction. The high degree of vertical compliance (10^{-6} cm/dyne) is, of course, important where the well known "pinch effect" is concerned.

The mechanical noise radiated from pickups having a large armature area rigidly connected to the stylus tip can be most objectionable; here again the excellent vertical compliance is beneficial and the area of the rod magnet is smaller than that of most moving coils.

The Yoke and Coils.—The yoke must have high initial permeability and Mumetal was chosen for this part. It is in the form of a strip of 2 sq mm cross-sectional area, bent to the required shape.

The magnetic induction in the yoke is very low compared with the saturation induction of the material and distortion due to saturation is impossible. Only a part of the magnet flux passes through the yoke (the remainder completes its circuit in the air).

The two coils, total impedance 5,000 ohms, form an approximately astatic system. They are wound on the arms of the yoke and this, together with the armature and bearings, is contained in a cast block of polyester resin. The whole assembly is provided with a Mumetal screen and a robust "cartridge" is thus formed, proof against tropical climates. Both the yoke and the magnetic screen are connected, via the pickup lead, to the amplifier, thus suppressing any noise due to static electricity generated by the friction between stylus and record.

The Arm.—This is straightforward in design and is equipped with a continuously variable counterweight giving a playing weight range of 0-10 gm. No springs are used. Recommended playing weight for general use is 5-6 gm, although the pickup will track satisfactorily below this on a great many records when conditions are good. The author has particularly in mind accurate levelling of the record playing equipment, to avoid unwanted lateral forces on the arm.

It is often maintained that a spring adjustment of playing weight is best because it enables a lighter arm to be used. This is true, but a light arm does not guarantee a small inertia. The case for and against has been neatly summed up by Barlow[2].

A point of some interest is that any ferrous metal can be used for the turntable in any system which incorporates the magnetodynamic pickup. This is not the case with moving coil pickups, where the large magnet would exert an appreciable force on a ferrous turntable with a consequent increase in playing weight.

Frequency Response.—In record reproduction, the upper limit of frequency response may be determined by a resonance or by a tracing loss concerned with the relative amplitudes of the stylus and recorded groove being traced[3]. So far as resonance is concerned, this may be due solely to the pickup's moving system, or it may be the compliance of the record material resonating with the effective mass at the stylus tip.

The magnetodynamic pickup's armature resonance occurs at about 26 kc/s and it is therefore, the "groove stylus" resonance, depending on record material characteristics, which imposes the upper frequency limit. This lies at 18-19 kc/s for microgroove records in the present state of the art. The output voltage of the pickup, then, is proportional to recorded velocity up to this limit. Reference was made above to a tracing loss and, this, rather than a resonance, will impose the upper frequency limit when the pickup approaches the inner grooves of the record. The effect is, unfortunately, one that is inherent in reproduction from disc records.

The low-frequency response of a pickup is usually limited by resonance, and it is generally agreed that this, since it cannot be eliminated, must be kept at as low a frequency as possible by good arm design and attention to the compliance of the armature system. If a maximum is set for armature restoring force in the interests of a low resonant frequency, it is equally true for many magnetic pickups that a certain

minimum force is necessary to centre the armature in opposition to the magnetic field.

It follows that a reduced field—and signal voltage—usually accompanies low resonant frequency. These considerations apply to the magnetodynamic pickup in principle, but the very small field acting against restoring force makes possible an excellent relationship between output voltage and the compliance value quoted earlier, with a smooth response extending to 25 c/s.

Intermodulation distortion tests using 60 and 4,000 c/s tones at 4:1 ratio, gave the low figures of 0.6% at 8 cm/sec and 1.4% at 20 cm/sec recorded velocity. The figures are, of course, for pickup and record together.

REFERENCES

[1] Went, J. J. *Philips Technical Review.* Vol. 13, pp. 194-208. 1951-2.

[2] Barlow, D. A. *Wireless World.* June 1957.

[3] Kerstens, J. B. S. M. *Philips Technical Review.* Vol. 18, pp. 89-97. 1956-7.

Commercial Literature

Transformers for mains, audio, e.h.t. and low-voltage applications; also smoothing chokes. A comprehensive catalogue giving electrical data, physical dimensions, mechanical drawings, and a price list from Gardners Radio, Somerford, Christchurch, Hants.

Magslips; a 60-page publication dealing with their history, fundamental principles, use in systems and circuits and applications in analogue computing; with electrical and mechanical details and information on power supplies, measurements, tests and fault location. From Muirhead and Co., Beckenham, Kent. Also a leaflet on their range of synchros and servo motors.

Aerial Installation for communications receivers. A booklet "Better Radio Reception," giving advice on aerial erection and interference suppression for land and ship stations, from Eddystone (Stratton and Co.), West Heath, Birmingham 31, price 1s.

Carbon Coated Resistors on ceramic rod with axial wire leads (no caps), giving reductions in length and diameter. Details of these and other carbon-coated and wire-wound precision types made by Resista Fabrik Elektrischer Widerstände of W. Germany, in a catalogue from G. A. Stanley Palmer, Maxwell House, Arundel Street, London, W.C.2.

G.E.C. Valve Manual, Part I, second edition, covering receiving and industrial valves, television and instrument c.r. tubes, semiconductor diodes and transistors, neons, photocells, barretters, corona stabilizers and G-M tubes. Also tables of equivalents, valves in G.E.C. receivers and data on obsolete types. From the General Electric Company, Magnet House, Kingsway, London, W.C.2, price 7s 6d.

A.C. Voltage Stabilizers in rack-mounted form suitable for direct incorporation in equipment. Load ratings range between 1.61 and 12.19 kVA, the accuracy is ±0.5 per cent, while the correction rate is 40 volts per second for one design and 1 volt per second for another. Leaflet from Claude Lyons, Valley Works, 4-10 Ware Road, Hoddesdon, Herts.

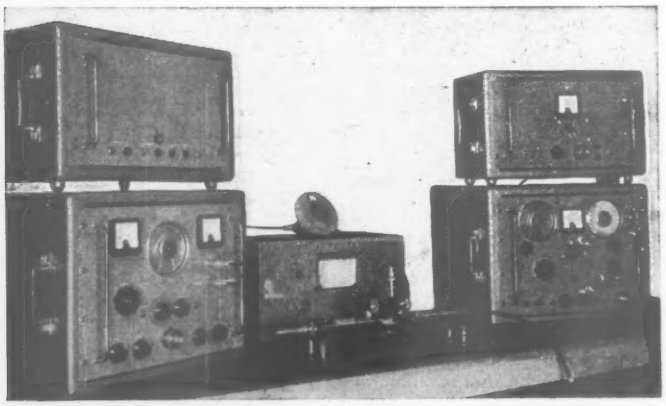
Hi-Fi Furniture.—The provision of various styles of cabinets for sound reproduction equipment to suit customers' existing furnishing schemes is part of the service offered by Largs and described by them in a booklet from their establishment at 76-77, High Holborn, London, W.C.2. Cabinets can be "tailor made" if necessary.

Three-pole Switches, suitable for 3-phase power switching, with a sliding action contact mechanism which ensures simultaneous breaking of all three contacts. These and other Cutler-Hammer types described in a leaflet from NSF, Keighley, Yorks.

Screened Leads, microphone cables and equipment connecting wires; a brochure from The Telegraph Construction and Maintenance Co., Mercury House, Theobald's Road, London, W.C.1.

Batteries and Accumulators, Exide and Drydex, for receivers, hearing aids, torches and other electrical apparatus. A catalogue giving sizes, weights, voltages and prices, including a replacement list of types suitable for battery receivers, from Chloride Batteries, Exide Works, Clifton Junction, Swinton, Manchester.

"Modular" Cushioning, made of rubberized hair, for protecting equipment in transit. The "modules" are small blocks of the material on a ⅛-inch flexible backing which can be either cut to separate the blocks or used as a "hinge" when disposing them around corners, etc. Illustrated brochure, showing arrangements required for various loads, from Hairlok Laboratories, Power Road, Chiswick, London, W.4.



U.H.F. Link Test Equipment

For testing u.h.f. multi-channel links a number of special types of equipment are needed. A small exhibition of such test apparatus made by Marconi Instruments, Ltd. and suitable for frequencies from 1,700 to 2,300 Mc/s was held recently. The u.h.f. receiver, signal and noise generators, associated power pack, wavemeter and precision slotted line shown in the photograph formed part of this exhibition.

Vortexion

TAPE RECORDERS and AMPLIFIERS

The above recorder uses a synchronous capstan motor and for use on 12 volt car battery a 50 c/s ±1 cycle 230 v., 120 w. power supply unit is available.

T.R.G.10 MINIATURE AMPLIFIER AND VERSATILE PRE-AMPLIFIER. A modern miniature amplifier, measuring only 4½ x 5in. over front panel and projecting 10½in. to the rear. Uses C core transformer material to obtain low external magnetic field and has less than 0.1% harmonic distortion at 10 watts output. The amplifier response is level 15 c/s. to 50,000 c/s. within 0.2 db. The 3-valve pre-amplifier will operate direct from recorder heads with correction networks for different tape speeds and switched inputs are provided for radio, microphone and gram. with correction for all recording characteristics.

"SUPER FIFTY WATT" AMPLIFIER. This heavy duty amplifier is available for long life under arduous conditions. The normal life being 5,000 hours without valve change.

★ The total hum and noise at 7½ inches per second 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc., Variable bass and treble controls are fitted for control of the play back signal.

★ The power output is 4 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The play back amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

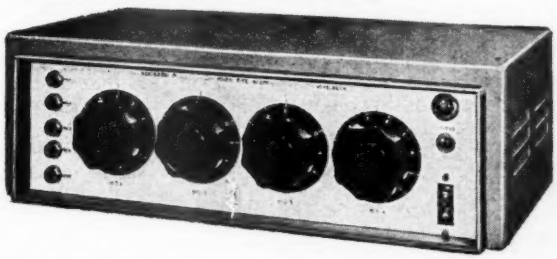
★ The unit may be left running on record or play back, even with 1,750ft. reels, with the lid closed.

CP20A AMPLIFIER. This standard amplifier for extreme tropical use will operate from 230 v. A.C. mains or 12 v. car battery and give 15 w. output for a consumption of 5.5a. Inputs for 30 Ω balanced microphones, M.I. P.U. and Cr. P.U.

FOUR CHANNEL ELECTRONIC MIXER

An Electronic Mixer for four 30-50 Ω balanced line microphones or special to order. Normal output 0.5 v. on 20,000 Ω but 1 mW., 600 Ω balanced or unbalanced is available as an alternative.

The 3-CHANNEL MIXER and PEAK PROGRAMME METER is similar to the above but is fitted with a meter reading peak signals with 1 second decay time and calibrated in dbs from zero level 1 mW., 600 Ω to +12 and −20 balanced or unbalanced output by means of switch.



Full details and prices of the above on request

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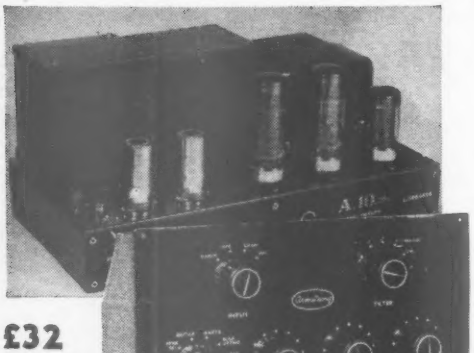

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Output: 10 watts (nominal), 20 watts peak. *Frequency Response:* 10-100,000 cps, with 1 dB 15-30,000 cps. *Distortion:* Less than 0.1%. *Damping Factor:* 40. *Hum Level:* better than 80 dB down. *N.F.B.:* 3 loop, main overall loop 28 dB from testiary winding of output transformer. *Sensitivity:* 18 mV (Gram input A) for 10 watts. *Spare power supplies:* 320 V. at 50 mA and 6.3. V at 2 amps.

CONTROLS

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IA63

More Transformerless Amplifiers

RECENT WORK ON SINGLE INPUT SERIES-CONNECTED OUTPUT STAGES

IT seems to be an example of some natural law of cussedness that review articles are rapidly followed by a spate of further publications on the subject; and the article on "Output Transformerless Amplifiers" (February, 1957, issue, p. 58) has proved no exception. As some of this further work has followed what were only sidelines of the original article, further information is given here, together with notes on other developments.

The Philips single input series-connected output stage (shown in Fig. 1, based on Fig. 3 on the Feb., 1957, article) has been more fully described[1]. The signal input for the upper valve already contains second-harmonic distortion produced by the

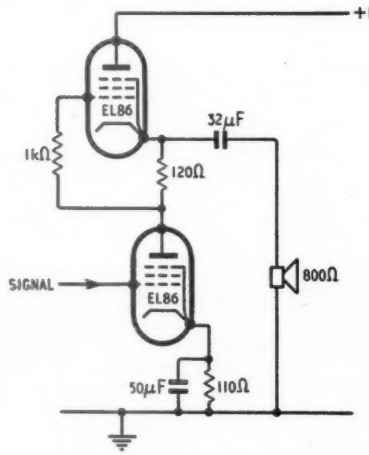

Fig. 1. Philips single input series-connected output stage.

lower. This will give second harmonic in the upper valve by *amplification*, and this will be out of phase with the second harmonic produced by *distortion* in the upper valve. The signal input for the upper valve is out of phase with that for the lower as it is produced by amplification in the lower valve. Thus the second harmonic distortions generated by the valves themselves tend to cancel in the load, as in a push-pull stage. The second harmonic conveyed to the load by amplification in the upper valve can then only be cancelled as well if the upper valve contributes more out-of-phase second harmonic distortion. One way of achieving this is to decrease the distortion produced by the lower valve by using an un-bypassed cathode bias resistor to give current feedback. However, this increases the output impedance and necessitates a higher input voltage. It is better to shift the working point of the upper valve in the direction of increased distortion by altering the value of the cathode bias resistor, although this gives exact compensation at only one value of the output. In practice it was found that this adjustment of the working point was only critical for low outputs. Using two EL86s and no feedback, 9 watts output at 10% total distortion was obtained. This distortion included 8% third harmonic and 6% second harmonic. Results are also given in ref. 1 for the cases when the current of either or both EL86 valves is 25% less or greater than the rated value. The output impedance of this type of circuit is lower than that for the two valves in parallel because the upper valve operates rather like a cathode follower in which only part of the output is fed back.

The two versions of this circuit with one of the output pentodes replaced by a triode are also analysed in ref. 1. The maximum output power is obtained when the contribution from the triode is very small or zero. The performance is however then inferior to that of a single class-A operated pentode, both as regards output power and distortion.

Circuits similar to Fig. 1 have also been described in refs. 2 and 3. In ref. 2 it is used as the basis of a high-level, video-frequency modulator. In this application the load is very non-linear as it consists of a capacity in parallel with an effective resistance determined by the grid current in the following stage, i.e., a resistance varying with the output level. In ref. 3 the upper valve is used to provide a high effective resistance to increase the gain of the pentode lower valve.

An analysis of various types of phase inverter connected as in Figs. 7, 8 and 9 of the February, 1957, article with emphasis on obtaining equal drive in the output valves independent of the value of the load has been published by Amemiya[4]. This shows the at least geometrical similarity between Figs. 7 and 9 of the February, 1957, article, where in each case one return from the phase inverter is taken to the anode-cathode join of the output valves. Ref. 4 also shows how in the Coulter circuit (Fig. 8 of the Feb., 1957, article) the drive in the output valves can be made independent of the load value by choosing suitable values for the feedback fraction and the fraction of the input fed to the phase inverter.

Peterson-Sinclair Circuits

The Peterson-Sinclair output stage[5] (shown in Fig. 2, based on Fig. 9 of the Feb., 1957, article) has been analysed by several authors[1, 4, 6, 7, 8]; refs. 4, 6, 7 and 8 emphasizing methods of obtaining equal drive in the output valves independently of the load. Ref. 6 also discusses the optimum valve and operating parameters. Ref. 1 points out that if tetrodes or pentodes are used for the output valves, then the anode current for the lower will exceed that for the upper by the screen grid current, so that the operating points for the two valves will not be identical. Bypassing the lower valve

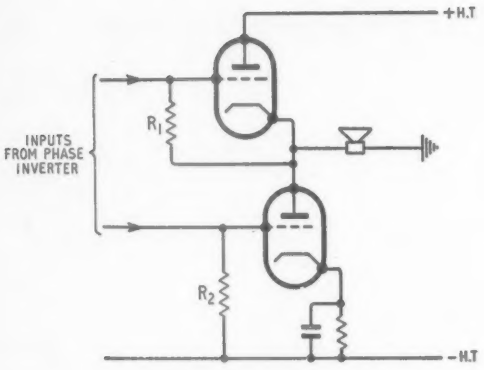

Fig. 2. Peterson-Sinclair output stage.

by a suitable resistor will compensate for this unbalance, though strictly only for one value of the output power.

The effect of the feedback via the anode voltage of the phase inverter in the Peterson-Sinclair output stage is calculated in refs. 1 and 6. According to the former, the reduction in the distortion is only slight and considerably less than the reduction in the output impedance. In one practical case the reduction ratios were 1.07 and 6.6 respectively.

The effect of the stray capacity at the upper phase inverter load R_1 in Fig. 2, is also calculated by Yeh.[6] As pointed out by Peterson and Sinclair[5], because this load is connected in series with the output, this stray capacity is effectively multiplied by one plus the gain in the output stage, much as in the Miller effect. This effect does not occur at the lower phase-inverter load R_2, so that there is some unbalance at high frequencies. In the region where the gain is not affected by phase shift, this can obviously be compensated for by putting an equal effective capacity across the lower phase-inverter load. This was done in practical amplifiers described in Refs. 1 and 8. In Ref. 1, with no feedback, the response was only 3 dB down at 650 kc/s using two EL86s as output valves and half an ECC83 as phase inverter. Figures for the variation of the distortion in this circuit with load value, power output and supply voltage are also given in ref. 1. The distortion appears to fall just before full output. In the amplifier described in ref. 8, using two triode connected 50L6s as output valves and a 6SN7 as cathode-coupled phase inverter, the frequency response was 3 dB down at about 200 kc/s with 20 dB overall feedback. 3 watts with 0.7% intermodulation distortion were obtained in a 600-ohm load.

Another Philips practical circuit similar to Fig. 4 of the Feb., 1957, article, but with a more elaborate phase inverter consisting of two cathode-coupled valves in cascade has been described. [1, 9, 10, 11] The common cathode resistor produces positive feedback in the phase inverter stage. It is shown in refs. 1 and 9 that if this feedback is adjusted so that this stage by itself would be on the verge of instability, then the output stage does not contribute to the total distortion in the amplifier. The whole amplifier can be stabilized with overall negative feedback provided that the output stage and feedback loop do not introduce any undesirable phase-shifts. This proviso can be satisfied much more easily if there is no output transformer. Using two EL86s as output valves to feed an 800-ohm load, 10 watts output with a total harmonic distortion of 0.3% was obtained. The high frequency response was 3 dB down at 250 kc/s, and the output impedance only about 20 ohms.

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[1] "Single-Ended Push-Pull Output Stages," *Electronic Applications Bulletin*, Vol. 17, No. 3, May 1957, p. 81.

[2] V. S. Cooper, "Shunt-Regulated Amplifiers," *Wireless Engineer*, Vol. 28, No. 5, May 1951, p. 132.

[3] G. E. Valley and H. Wallman, "Vacuum Tube Amplifiers," M.I.T. Radiation Laboratory Series, Vol. 18, pp. 432-439 (McGraw-Hill).

[4] H. Amemiya, "Analyses of Drivers for Single-Ended Push-Pull Stage," *I.R.E. Trans., Audio*, Vol. AU-3 No. 5, Sept.-Oct. 1955, p. 162.

[5] A. Peterson and D. B. Sinclair, "A Single-ended Push-pull Audio Amplifier," *Proc. I.R.E.*, Vol. 40, January 1952, p. 7.

[6] C. Yeh, "Analysis of a Single-Ended Push-Pull Audio Amplifier," *Proc. I.R.E.*, Vol. 41, No. 6, June 1953, p. 743.

[7] H. Amemiya, "The Extended Cathode-Coupled Phase Inverter and its Application to Single-Ended Push-Pull Amplifiers," *Jnl. A.E.S.*, Vol. 3, No. 2, April 1955, p. 82.

[8] H. Amemiya, "An Output Transformerless Amplifier," *Jnl. A.E.S.*, Vol. 4, No. 2, April 1956, p. 72.

[9] J. R. de Miranda, "Audio Amplifiers with Single-Ended Push-Pull Output," *Philips Technical Review*, Vol. 19, No. 2, 1957, p. 41.

[10] J. R. de Miranda, "Versterkers met Direct Gekoppelde Luidsprekers," *Nederlands Radiogenootschap*, Vol. 22, No. 1, Jan. 1957, p. 15.

[11] J. R. de Miranda, "Hi-Fi Philosophy from a European Point of View," *I.R.E. Trans., Audio*, Vol. AU-5, No. 4, July-Aug. 1957, p. 82.

[12] J. Futterman, "A Practical Commercial Output-Transformerless Amplifier," *Jnl. A.E.S.*, Vol. 4, No. 4, October 1956, p. 163.

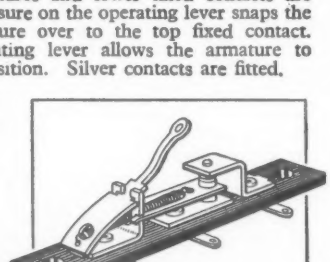
[13] L. H. Light, "Feedback Arrangements in Transformerless Push-Pull Output Stages," *Mullard Tech. Comm.* Vol. 3, No. 24, May 1957, p. 102. Refers to transistor output stages.

Skeleton Snap-action Switch

RECENTLY introduced by Arcolectric (Switches), Ltd., Central Avenue, West Molesey, Surrey, is a new sensitive skeleton-type snap-action switch intended primarily for incorporating in small industrial equipment. It is a single-pole change-over type operating on the microgap principle and measures $2\frac{1}{2}$ in $\times \frac{3}{4}$ in over the connecting tags. The height is under $\frac{3}{4}$ in.

At rest the armatures and lower fixed contacts are closed and light pressure on the operating lever snaps the spring-loaded armature over to the top fixed contact. Releasing the operating lever allows the armature to return to its rest position. Silver contacts are fitted.

The switch, Model T280, is rated at 3 A, 250V and is for a.c. circuits only; it costs 3s 6d



Arcolectric Model T280 skeleton snap-action switch.

News from the Industry

E.M.I. Records, who provided the tape recording used by the B.B.C. in its recent stereophonic test transmissions, announce that they have been building up a library of stereo tapes during the past few years and, therefore, have the material for processing stereo discs. Before putting them on the market they are developing a suitable pickup. The first E.M.I. stereo discs could be available in about a year.

Elliott Brothers (London), Ltd., who have had for some time a special department for the sale and servicing of American-made Bendix aviation and radio equipment, have discontinued this department. They will now concentrate on the manufacture in this country under licence of the wide range of Bendix-designed equipment.

Semiconductors, Ltd., the recently formed Plessey subsidiary, expect that their transistor factory now being built at Cheney Manor, Swindon, Wiltshire, will be in production by the middle of this year. The air-conditioned factory has no windows, is clad entirely with aluminium panelling, and all interior surfaces are coated with p.v.c.

Marconi Instruments have received an order from the Ministry of Supply for a quantity of f.m./a.m. signal generators for use by the army. The order, valued at nearly £70,000, calls for 117 signal generators Type TF937, which cover the frequency range 85 kc/s to 30 Mc/s, and 94 Type TF995A/3/S covering 1.5-220 Mc/s in five bands.

A. H. Hunt (Capacitors), Ltd., announce that they have discontinued the sale of the CRB3 capacitor analyser and resistance bridge. It will in future be marketed by their subsidiary, F. C. Robinson & Partners, Ltd., of Councillor Lane, Cheadle, Cheshire. The price of the CRB3 has been increased to £27 10s.

E.M.I. Electronics, Ltd., have supplied a substantial part of the television equipment for the studios of the I.T.A. programme contractors T.W.W., Ltd., at Pontcanna, Cardiff. The equipment includes two film-scanning channels, some 30 picture monitors, line selector instruments and two mobile microwave links.

Cossor (Ireland), Ltd., has been formed in the Republic of Ireland to distribute Cossor domestic sound and television equipment. It will also market Cossor instruments and communications and navigation equipment. The address is 51, South William Street, Dublin (Tel.: Dublin 72080).

Texas Instruments, Ltd., who started transistor production at their Bedford factory in September, announce substantial price reductions of silicon transistors. The lowest-priced small-signal type (2S001) is reduced from £4 6s to £3 15s, and the highest-priced high-power type (2S012) from £32 5s to £29.

Solartron Electronic Group had a turnover during the year ended June 30th of over £1M—an increase of £250,000 over the previous year. During the last three years its staff has increased from 240 to 600 and floor space occupied from 30,000 to 70,000 square feet.

Marconi Marine have been installing new transmitters and radar equipment in the liner *Mauretania* while she has been undergoing a major refit at Liverpool. The new radar equipment, the "Radiolocator IV", provides the navigator with three alternative types of display, "north stabilized", "ship's head up", or "track indication" giving the course and speed of responses.

Stability Capacitors, Ltd., of Commerce Estate, Raven Road, London, E.18, have been formed to market the silvered ceramic and silvered mica capacitors manufactured by Stability Radio Components, Ltd., which will continue purely as a manufacturing concern. The directors of both companies are W. Schick and A. Schick.

Quality approval by the Services of the Sentercel silicon power diodes RS20A, RS21A and RS22A is announced by the Rectifier Division of Standard Telephones & Cables.

Amplivox, Ltd., have been awarded a further series of contracts (£10,000 approx.) by the Ministry of Transport and Civil Aviation for the supply of lightweight headsets.

R.E.E. Telecommunications, Ltd., of Somerset, have acquired new premises at 15a, Market Square, Crewkerne, Somerset (Tel.: Crewkerne 662), to which all correspondence regarding their v.h.f. radio-telephone equipment should be addressed.

Perth Radios, Ltd., which was formed in 1953, recently moved from Judd Street, London, W.C.1, to Marten House, East Road, London, N.1. Production of radio-gramophones is now at the rate of 280 per week. The founder and managing director of the company is M. H. Ismail, who came to this country from Pakistan in 1953.

Aerialite, Ltd., have opened a larger Glasgow distribution centre at 311, Bell Street, C.4 (Tel.: Bell 2014/5).

Bradmatic Productions, Ltd., has been formed jointly by Bradmatic, Ltd., the tape-recorder manufacturers of Witton, Birmingham, and Littlewood Bros. (Aerials), Ltd., aerial installers, of Handsworth, Birmingham. The new company, which has its offices at Soho Hill, Birmingham, 19, will undertake large-scale production of a range of equipment including tape-recorder heads and fractional horse-power motors.

EXPORT NEWS

Hanover Fair.—A group of nine companies—English Electric, Gresham Transformers, Painton, British Electric Resistance Co., Pena Industries, Peto Scott, Geo. Bray, Cosmocord and Ardente—have formed what is to be known as Electronics Components Centre (Great Britain), Ltd., to sponsor a joint exhibit at the Hanover Fair (April 27th-May 6th). R. W. Hardisty is secretary of the organization, which has offices at 8 West Street, Epsom, Surrey. The company, which has been formed because of the stipulation that a 10-year contract to exhibit at the fair has now to be signed, will organize a British Electronics Centre at Hanover and possibly at other fairs in the European Economic Community.

A Decca Navigator Chain is to be established in the New York area. The contract has been placed with Bendix-Pacific, the United States licensees of the Decca Navigator Co., by the Air Modernization Board. The chain, which is planned to be brought into service by April 1st, will be the fifth in the Western Hemisphere—four were opened in Canada last year.

Italy.—A section of the 36th International Fair being held at Padua from May 31st to June 15th is to be devoted to sound and television equipment. Further information can be obtained from the sole agents in the U.K.—Auger & Turner Group, Ltd., 40 Gerrard Street, London, W.1 (Tel.: Gerrard 4951).

Nuclear Instrumentation and control circuitry for Denmark's new research reactor to be constructed at Risö, is to be provided by Ekco Electronics.

Electronic equipment for the defence forces of the German Federal Republic to the value of £500,000 has been ordered from Decca Radar, Ltd.

Airborne Radar.—The Vickers "Viscount" airliners operated by the Iraqi Airways are being fitted with Ekco Search Radar.

Test Equipment.—J. H. Buying, who has been with Marconi Instruments seven years and was recently appointed sales engineer for Africa and the Middle East, is on a four months' tour of Africa. He will be visiting the Sudan, Ethiopia, Aden, Kenya, Tanganyika, Central African Federation, Portuguese East Africa, Union of South Africa, Belgian Congo, French Equatorial Africa, Nigeria, Ghana and Sierra Leone.

An I.S.B. transmitter is being supplied by Marconi's for installation at the station of the South African Posts and Telegraphs Department at Klipheuvel. The 10-kW h.f. transmitter, which replaces equipment supplied by Marconi's in 1930, will be used for telegraph and telephone traffic with the U.K.

British Columbia.—An International Trade Fair is being sponsored by the government of British Columbia to mark the centenary of the Province. It will be held in Vancouver (May 1st-10th) and one of the sections will include sound and television equipment, precision instruments and electrical equipment.

Sound Reproducing Equipment.—Birmingham Sound Reproducers announce that orders from the U.S.A. for delivery in the first quarter of this year exceed $2.5 million.

A Belgian office has been opened by Evershed & Vignoles, Ltd., at 142, rue Gallait, Brussels, where the company's range of instruments and control equipment will be available for Belgium, Belgian Congo and Luxemburg.

MARCH MEETINGS

LONDON

4th. I.E.E.—Discussion on "Some impressions of technical and industrial training in the United States" opened by Dr. K. R. Sturley at 6.0 at Savoy Place, W.C.2.

10th. I.E.E. Graduate and Student Section.—"The International Geophysical Year" by Sir Archibald Day at 6.30 at the Institution of Civil Engineers, Great George Street, S.W.1.

12th. Radar Association.—"The Jodrell bank radio-telescope in action" by Prof. A. C. B. Lovell at 7.30 at the Anatomy Theatre, Gower Street, W.C.1.

13th. Television Society.—"Transistors in television receivers" by B. Overton (Mullard Research Labs.) at 7.0 at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, W.C.2.

18th. Institute of Physics.—"Microwave ferrites" by L. A. Thomas (G.E.C. Research Labs.) at 5.30 at 47 Belgrave Square, S.W.1.

18th. Brit. I.R.E.—Discussion on the Technical Committee's report "Recommended method of expressing electronic measuring instrument characteristics: (1) a.m. or f.m. signal generators" at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

19th. I.E.E.—"Efficiency and reciprocity in pulse-amplitude modulation" (1) Principles by K. W. Cattermole; (2) Testing and applications by J. C. Price; and "Transistor pulse generators for time-division multiplex" by K. W. Cattermole at 5.30 at Savoy Place, W.C.2.

21st. R.S.G.B.—"The junction-type transistor and its application to short-wave radio" by E. Wolfindale and L. E. Jansson (Mullard) at 6.30 at the I.E.E., Savoy Place, W.C.2.

25th. I.E.E.—"The atomic clock" by Dr. L. Essen at 5.30 at Savoy Place, W.C.2.

26th. Brit. I.R.E.—"Electronics in medicine" by R. F. Farr at 6.30 at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1.

27th-28th. I.E.E.—Convention on radio aids to aeronautical and marine navigation at Savoy Place, W.C.2.

28th. Royal Institution.—"Hearing in man and animals" by Dr. R. J. Pumphrey (Derby Professor of Zoology, University of Liverpool) at 9.0 at 21 Albemarle Street, W.1.

31st. I.E.E.—"Future radio-communication methods for civil aircraft" by W. E. Brunt at 5.30 at Savoy Place, W.C.2.

ARBORFIELD

11th. I.E.E. Graduate and Student Section.—"The fidelity limits of monaural sound reproduction" by J. B. Helder at 7.0 in the Assembly Hall, 3 (Tels.) Training Bn., R.E.M.E.

BEDFORD

11th. I.E.E.—"The transatlantic telephone cable" by R. J. Halsey at 6.30 at the Swan Hotel.

BIRKENHEAD

21st. Brit. I.R.E.—"Radio exploration of the galaxy" by Dr. J. E. Baldwin at 7.0 at the Technical College.

BIRMINGHAM

24th. I.E.E.—"Colour television" by Dr. D. A. Maurice at 6.0 at the James Watt Memorial Institute, Great Charles Street.

BRISTOL

11th. Television Society.—Mullard film lecture on "Ultrasonics" at 7.30 at the Grand Hotel.

CAMBRIDGE

25th. I.E.E.—"Domestic high-fidelity reproduction" by J. Moir at 8.0 at the University Arms Hotel.

CARDIFF

14th. Institute of Physics.—"The cybernetic approach to mentality and society" by Dr. W. Grey Walter (Burden Neurological Inst.) at 5.15 in the Department of Physics, University College of South Wales and Monmouthshire.

CHATHAM

3rd. I.E.E.—"Electronics and automation—some industrial applications" by Dr. H. A. Thomas at 7.0 at the Medway College of Technology, Maidstone Road.

CHESTER

17th. I.E.E.—"Recent uses of ultrasonics in investigating the characteristics of materials" by Dr. J. Lamb at 6.30 at the Town Hall.

DUBLIN

20th. I.E.E.—"The design and acoustical treatment of broadcasting stations with particular reference to the new Radio Eireann Cork studio" by E. J. Slowey and P. A. Kneafsey at 6.0 in the Physical Laboratory, Trinity College.

EDINBURGH

18th. I.E.E.—"The B.B.C. sound broadcasting service on very-high frequencies" by E. W. Hayes and H. Page at 7.0 at the Carlton Hotel, North Bridge.

GLASGOW

13th. Brit.I.R.E.—"Automatic reading of typed or printed characters" by C. E. G. Bailey at 7.0 at the Institution of Engineers and Shipbuilders, 39, Elmbank Crescent.

HATFIELD

27th. I.E.E.—"Electrical synthesis of music" by A. Douglas at 7.0 at the Technical College.

IPSWICH

3rd. I.E.E.—"The B.B.C. sound broadcasting service on very-high frequencies" by E. W. Hayes and H. Page at 6.0 at the Crown and Anchor Hotel.

LIVERPOOL

31st. I.E.E.—"Colour television" by L. C. Jesty and Dr. E. L. C. White at 6.30 at the Royal Institution, Colquitt Street.

MALVERN

10th. I.E.E.—"Tracking the earth satellites with the aid of radio interferometry" by D. B. Yale at 7.30 at the Winter Gardens.

28th. Brit.I.R.E.—"Transistors in reception" by L. E. Jansson at 7.0 at the Winter Gardens.

MANCHESTER

19th. I.E.E.—"Domestic high-fidelity reproduction" by J. Moir at 6.45 at the College of Science and Technology.

26th. Brit.I.R.E.—"Electronic handling technique" by R. N. Settle at 6.30 at the Reynolds Hall, College of Technology, Sackville Street.

NEWCASTLE

3rd. I.E.E.—"Radio in air-sea rescue" by G. W. Hosie, D. Kerr and W. Kiryluk at 6.15 at King's College.

12th. Brit.I.R.E.—"Industrial television" by S. G. Gobbi at 6.0 at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road.

17th. I.E.E.—"Some transistor input stages for high-gain d.c. amplifiers" and "A transistor high-gain chopper-type d.c. amplifier" by Dr. G. B. B. Chaplin and A. R. Owens at 6.15 at King's College.

PAIGNTON

27th. B.S.R.A.—"A modern high-quality reproducing system" by H. L. York (Cape Electrophonics) at 7.30 at Standard Telephones & Cables, Brixham Road.

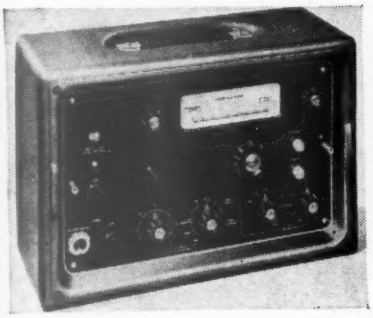
WOLVERHAMPTON

12th. Brit.I.R.E.—"Analogue computers" by K. C. Garner at 7.15 at the Wolverhampton and Staffordshire Technical College, Wulfruna Street.

MANUFACTURERS' PRODUCTS

Audio Oscillator

A CONTINUOUSLY variable control allows interpolation between adjacent fixed frequencies in the Wayne-Kerr S121 oscillator. Ten equally spaced fixed frequencies may be selected in each of four decade ranges to cover in all from 10c/s to 120kc/s. Alternative outputs are available, one at a level variable in 1 dB steps from +10 dB to −70 dB referred to 1 mW at an impedance of 600 ohms, and the other at a continously variable level in five decades up to 30 volts at an impedance of 3,300 ohms. Frequencies may be set to an accuracy of 1% or ±0.5c/s whichever is the greater, and the output level is constant to within 0.2 dB over the whole range. The total harmonic distortion is less than 0.2% from 300c/s to 20kc/s, and does not rise outside this range to more than 2.5% at 10c/s. The instrument costs £130 and the address of the manufacturer is Wayne Kerr Laboratories, Ltd., Roebuck Road, Chessington, Surrey.



Left : Wayne Kerr audio oscillator offering continuous variation between fixed frequencies.

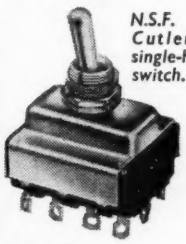
Tape Revolution Counter

THE photograph shows how the new Philips EL3979/17 three-digit revolution counter may be readily fitted to their AG8109 tape recorder. Attachment to their models AG8105 and AG8107 is also possible via the carrying handle. In each case the plastic cap at the end of the drive cable is simply pushed over the top of the spool spindle. A reset wheel is fitted to the counter. The price of the counter is £3 7s 6d.

Philips tape spool revolution counter.

Appliance Switches

TO their range of Cutler-Hammer appliance switches N.S.F. Ltd., 31-32, Alfred Place, London, W.C.1, have added several new one-hole fixing 3- and 4-pole models rated at 10A on 250V a.c. supplies or 20A in d.c. circuits not exceeding 24 volts.



N.S.F. new 4-pole Cutler-Hammer, single-hole fixing switch.

Measuring approximately 1⅞in × 1½in × 1⅛in the 3-pole type have spring-loaded silver-alloy contacts with sliding action arranged to break simultaneously all 3 circuits. The switches are lever operated and available with either a 2- or a 3-way movement. The 2-way provide "on/off" switching and the 3-way has a centre "off" position with an "on" position either side of it.

Apart from their usefulness in various electrical appliances both models have many applications in electronics, process control and automatic production systems.

Design Pointers

THE current issue of *Design*, published by the Council of Industrial Design, includes an appreciation of details in the design of the Vidor "Vagabond" receiver. Considering the general status of the portable set the authors point out that because of the increasing interest in television, sound radio receivers have become ancillary equipment and the portable is no longer part of picnic equipment but "is about to develop as a general purpose instrument which is neither luggage nor furniture."

Basic functional requirements for the design of dials are considered by Brian Shackel, of E.M.I. Electronics, in another article.

new

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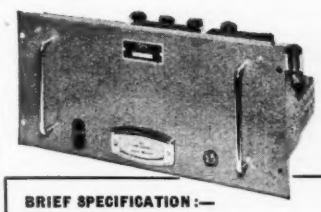

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RANDOM RADIATIONS

By "DIALLIST"

Is "Piping" the Answer?

A LETTER from a Portslade-by-Sea, Sussex, reader received early in January left me for some time completely flabbergasted. "I was glad," he wrote, "to see in the last lines of your notes this month confirmation of my views expressed in a letter to *W.W.* in last July's issue." The rest of his letter made it clear that he was referring to "piped" television. I knew I'd referred to this some time ago, but certainly not in the January, 1958, issue. A post or two later came the explanation. Both the '57 and '58 issues for January happened to be lying on his desk, each with a blue cover. He'd picked up the last year's one and had read the note I'd written about the difficulties of obtaining acceptable Band III reception in not a few parts of the Sheffield area. Well, over a year has passed since then and I can see no reason to change the opinion I then had that in some parts of the country, at any rate, the only complete answer seemed to be a service of "clean" TV signals sent over wires from a master receiving station operating in a place clear of all kinds of interference. Few people, I suppose, are more fortunately situated for television reception than I. My aerial is 60 feet above road-level and my home is on an open green, round which there is very little motor car traffic. There are no unsuppressed electrically driven machines and no flashing signs anywhere near. Aeroplanes rarely fly overhead. We are not in the service area of a Band III transmitter; but when our local station is brought into service I don't thing there'll be any bother.

The Not-so-lucky

Many others are not so well off. Unless we take real steps to protect their interests by outlawing preventable interference a large proportion of the nearly eight million television receiver owners in this country will have willy-nilly to put up with directly received pictures that are constantly upset or even blotted out by its effects. I do feel that in many built-up areas, particularly those containing tall metal-framed buildings and factories using a multiplicity of electrically powered machines, piping is likely to be the simplest and most effective solution of the problem. Nor can I see that there's any real reason for set manufacturers to be opposed to it. Why, for instance, shouldn't they make models specially designed to deal with piped signals where such are available? Surely, if a good picture, steady and immune from interference, could be guaranteed, the result would be larger sales and a greater number of satisfied customers.

Not Always So Simple

EVER since Jeans astonished the world by producing a scientific best-seller in his "Universe Around Us" there has been a steady flow of popular books on astronomy, physics, nuclear energy and other subjects. They are eagerly read by people athirst for knowledge, who either buy them, or borrow them from their county libraries. Many of them are quite admirable for their clear explanations of difficult things—in so far as they can be explained with a minimum of mathematics. Some, though, are apt to befog their readers quite needlessly by the use of physicists' jargon which is completely unintelligible to the man in the street. Why, for example, if the authors of such books mention Max Planck's equation, do they have to state it as $E=h\nu$? Many—perhaps most—of their readers are unfamiliar with the Greek alphabet and to such ν stands for vee and nothing else. I know that the physicists will steadfastly refuse to abandon ν in favour of f. By all means let them keep it, if they really feel that they need two letter symbols for the same thing, despite the fact that so many letters (μ, for instance) are hopelessly overworked in different—and not always so different—branches of science. But it's out of place in popular books. Confusion is worse confounded when they write power as joules/sec. Many people have never heard of such things, but they have at any rate some idea of what a watt is, for they know that a 75-watt lamp gives more light and consumes more current than a 40-watt. When American books of this kind make their way over here another snag crops up. American writers are fond of the word billion, which to them doesn't mean 10^{12}, as it does to our folk, but 10^9. I could go on and on with my protests, but readers will themselves think of many other instances they've come across of how simple-minded readers seeking for knowledge can be unintentionally blinded wi' science.

Optical "Noise" Filter

AS ONE who has to wear a very powerful lens in front of an eye damaged some years ago, I can possibly add my personal experiences to the opinions in letters in the January issue from T. G. Clark and E. R. Slaughter on pin-hole vision. In my work-room I have an old bracket clock with a nine-inch dial and stout black hands. Without the lens I find that I can not read the time at a distance of much over 15 inches. But looking through a pin-hole I find that I can do so quite easily (both hands and figures being seen sharply) at a good 10-12 feet. Years ago, I remember an eminent oculist telling me that the effect was exactly the same as that seen in the pin-hole camera: the small aperture cuts out the "noise" produced by light rays coming in at wide angles from the line of vision, brings the wanted rays to a focus and projects them on to the screen, photographic plate, or retina, as the case may be. Anyone, I think, who has to wear glasses will find that (though it's much more limited in angle) his pin-hole vision without glasses is as sharp and clear as his normal sight through spectacle lenses.

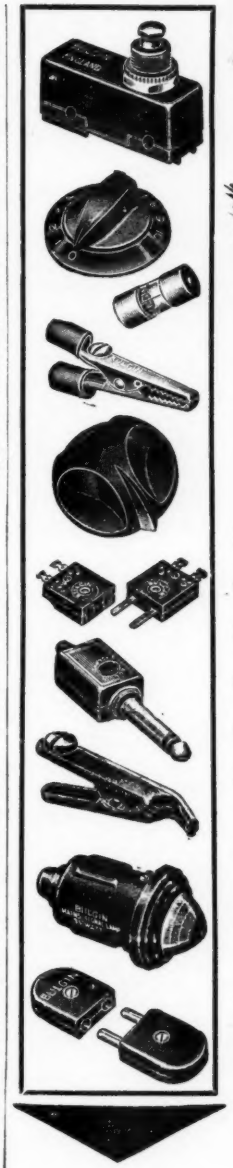
Why Not "Hi-Fi" TV?

THERE'S no question that the development of high-fidelity audio receivers and reproducers has been and continues to be an enormous success commercially. That makes me wonder why no manufacturer, so far as I know (if there be one, he has my humblest apologies), has yet turned his attention to the production of television sets which are of the genuine "Hi-Fi" order. It's been said that no one outside research establishments has ever seen the high quality which our 405-line transmissions are capable of showing on the TV screen. There's a whole lot in that, you know. Here are some points where a "Hi-Fi" set, costing

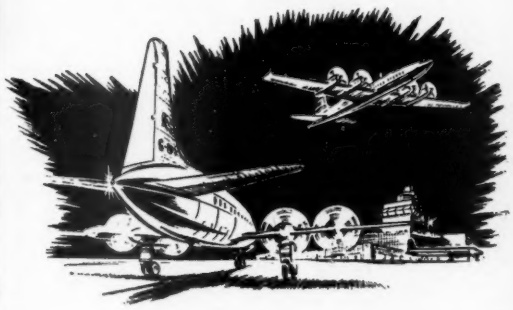
naturally a good bit more than the domestic receiver of to-day, could show its worth. The interlace would be perfect and the linearity both horizontal and vertical far better than it is in most sets. Sharp definition without a trace of ringing would be essential and there could be a considerable improvement in the tone gradations from black through dark grey and pale grey to white. A designer who hadn't to consider every penny would have full scope for improving automatic picture control and for obtaining a close approach to perfection in sync methods. People don't seem to mind much what they pay for "Hi-Fi" sound equipment and I honestly believe that the same would soon be true of television receivers that could be relied upon to bring out on their screens everything conveyed by the vision signals—and nothing else.

Direct from Heat

IT'S MORE than annoying to come across in one's morning paper an account written by a layman of some new development in wireless or electronics and to be unable to find either in it or elsewhere the technical particulars one wants. That happened to me last month, when I read a brief account of a thermionic convertor, developed by Dr. Volney C. Wilson, of the American G.E.C. Now I've got hold of details and pictures of the apparatus. The main idea is to convert heat direct into electricity without the use of any intermediate stages or moving parts. This can, of course, be done by the thermocouple; but the output is minute. Dr. Wilson's apparatus is in essence a diode and anyone who possesses a diode and a sensitive galvanometer can satisfy himself that the thing is possible. Connect the anode *via* the galvanometer to the cathode, switch on the l.t. and you'll find a deflection. What happens is that most of the electrons emitted by the cathode form the space charge surrounding it. But some of them are energetic enough to make their way to the anode, where they produce an electron surplus. Connect anode to cathode outside the bulb and these electrons cause a flow of current. Pictures show Dr. Wilson surrounded by giant diodes. Their cathodes are run at white heat and very promising results have been recorded. The efficiency is already as high as 8 per cent and it is hoped that as the process is developed efficiencies of 30-35 per cent may be reached.



SPEED . . .



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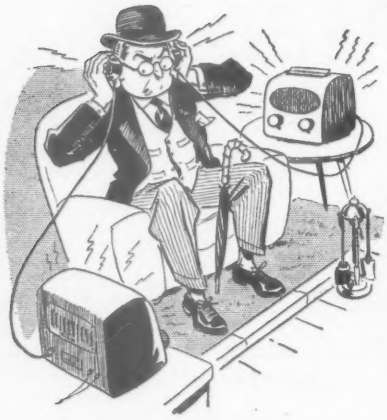


"I did as I was bidden" (or did he ?—Ed.)

"*Ni-Fi*" *Stereophony*

WHEN the B.B.C. carried out its experimental stereophonic transmissions in January, I did as I was bidden, placing one receiver to the left of me and t'other to the right. The results were certainly more than merely "hi-fi"; they were very nigh unto "ful-fi" and, therefore, worthy to be called "ni-fi."

But both Mrs. Free Grid and I felt that we were missing something which we should have got had we been present in the flesh at the original performance of the items being broadcast. It is not without significance, I think, that the B.B.C. makes use of the word "stereophonic" to designate these transmissions, for my much-tattered lexicon tells me that the Greek word "stereo" is a verb meaning "I rob, or deprive of something." Stereo, is, therefore, *le mot juste*, for I do feel that I am being robbed or deprived of something, namely, just that little extra realism which my presence in the studio would give me.

Having thus set the philologists by the ears and made them grab their pens to tell the Editor and me quite truly that the word "stereo" isn't derived from its Greek namesake at all, I will now proceed to do the same with the technologists by stating that true realism can only be obtained if the separate-channel link be maintained to the bitter end by using moving-coil headphones, with one earpiece connected to each of the two channels.

To those of you who use your heads for purposes other than that of keeping a hairdresser and his family in comfort, it should be quite clear that if you sit in the studio, listening to, say, a violinist, each ear receives the sound from its own particular "viewpoint." Above all, one ear can't possibly hear, even faintly, the sound which the other ear does.

But this is not so if one is sitting between two separate-channel loudspeakers. The left ear can and does hear, albeit faintly, the emanations from the right-hand loudspeaker, and vice versa. The disturbing effect is small but it does exist and only separate-earpiece headphones can make reception as truly binaural as it is in the studio.

In the world of steroscopy we are careful to use separate "eyephones." Although the cinemas have made gallant attempts to get rid of these by various subterfuges, they have never achieved quite the same degree of realism. In other words, their results are "ni-fi" like the B.B.C.'s recent stereophonic experiments.

By the way, can anybody tell me where I can get a pair of really "hi-fi fones," even better than the moving-coil types at present available. Preferably they should have two annular diaphragms, the outer one having an m.c. movement and the inner a piezo-crystal one. The centre core should, of course, be an electrostatic tweeter.

77 cm/sec and 78 r.p.m.

IT is difficult to find suitable words in which to express my thanks to Mr. H. Davies, of the B.B.C. Engineering Division, for the wealth of information he gave me in last month's issue about tape recorder speeds. The correcting of my ignorance was just the thing I was fishing for in my note in the January issue. I have always found that the best way to obtain information about any matter is to make a dogmatically tomfool statement about it or to ask a naïve question.

A remarkable instance of this occurred once when Mrs. Free Grid and I stood before a statue of Beethoven in Bonn. I had told her all about the terrible handicap of Beethoven's deafness, and her innocent question "Why on earth didn't the poor man invest in a good hearing aid?" instantly brought forth a wealth of information from one or two English-speaking teutonic bystanders eager to correct her terrible anachronism.

There is one point on which even Mr. Davies confesses himself ignorant and that is why the precise value of 77 cm/sec was chosen for the original magnetic recorder. My guess is that the reason was the same as that which led to the choice of 78 r.p.m. for the disc recorder. In both cases the figure could have been raised to a round 80 without causing technical trouble. The reason was probably that in each case the figure chosen represented the average of many experimental records made at slightly different speeds. However, I think I can hear, on my psychic receiver, the sound of several of you savants reaching indignantly for your pens.

My thanks are due also to the Editor for the support he gave me and I accept his rebuke for trying to immortalize one who was a commercial impresario of magnetic recording rather than a technological tycoon. On first thoughts I was afraid that the Editor had put me in a dilemma as a predecessor in the Editorial chair had added a comment to an earlier note I wrote about Herr Stille over a quarter of a century ago.

This note said that Stille was the *inventor* of magnetic recording. However, the Latin verb *invenire*, which gives us the word inventor, does not mean to "originate" but to "come upon, or find." This is exactly what Stille did. He came upon magnetic recording and proceeded to put it on the map. I think the same is true of Marconi with regard to radio.

Thus Stille was indeed the inventor of magnetic recording but only in the literal sense of the word. Therefore everybody is correct and I do not find myself in the unpleasant position of divided loyalties.

Technology Without Tears

I WAS very interested in "Cathode Ray's" article on atoms (February issue). He is a past master at "technology without tears" and I'm sorry he isn't going to deal with nuclear energy.

In view of what he wrote recently about the passing of the ether theory into the limbo of the lost, I wish he could give us an article in Lewis Carroll style called "Alice in Waveland."

"Go and have a bathe, child," said the Red Queen, "but be careful that the waves don't knock you over."

"But there is no sea to have a bathe in," protested Alice.

"I never said there was," replied the Queen, "I meant you to bathe in the sea waves and warned you to be careful that they didn't knock you over."

"But how can there be waves without any sea for them to travel in," asked Alice in a bewildered tone.

"You're just being stupid," said the Queen and turning to her executioner snapped "Off with her head."

Britain's best Hi-Fi Equipment

We have devoted over 23 years entirely to the design and manufacture of audio equipment and we are proud of our position as leaders in this field. We were the first firm in the world to design and market Amplifiers having a total distortion content as low as 0.1%; a claim which was received with incredulity in 1945, but which was subsequently confirmed by the National Physical Laboratory and has become an accepted world-wide standard.

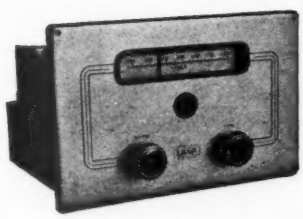
High engineering ideals have guided our efforts, and Leak Amplifiers have been the choice of the B.B.C., Commonwealth and foreign broadcasting authorities and Recording Studios. This acceptance by professional audio engineers has led to a demand for Leak equipment from music lovers throughout the world.

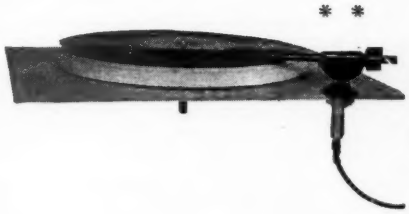
On the important question of prices it is appropriate to mention one of the basic principles of Leak design. From long experience and by extreme attention to design details during development work on the pre-production models, we enable our craftsmen to achieve a high output per man-hour. The labour costs thus saved offset the increased cost incurred for high-grade materials, components and finishes, and this, together with quantity production (made possible only by a world-wide market), explains how quality products may be sold at reasonable prices.

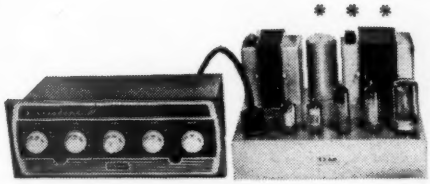
An important Test Report . . .

Independent laboratory tests of the Garrard 301 transcription turntable were recently carried out by Audio Instrument Company Inc., New York, U.S.A., under the direction of Mr. C. J. Lebel (Chairman of one of the groups which prepared the NARTB Standards). It was necessary that the pick-up and amplifier system should conform in response to the RIAA-new AES-new NARTB response curve within ± 1 db. and in the tests of this excellent transcription unit ***the components selected for use as complying with this requirement were a Leak tone arm fitted with Leak cartridge and a complete Leak pre-amplifier and power amplifier Model TL/10.***

The full test report appeared in the February, 1957, issue of "Wireless World," pages 22 and 23.







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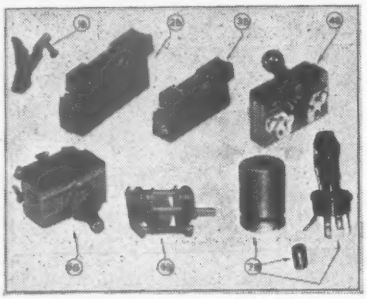
.....

W W./3/58



1b. Crocodile clip for metering etc. Has sharp point for piercing insulation without spoiling it. **8d.** each or **7/-** per dozen.

2b. 15 amp siydiok panel mounting fuse and fuse carrier. **2/6.**

3b. 5 amp siydiok panel mounting base and fuse carrier. **2/-.**

4b. Double pole 15 amp toggle switch, ex. equipment but unused. **1/9.**

5b. 5 amp double pole change-over toggle switch (DP/DT), ex. equipment but unused. **2/6.**

6b. Air spaced trimmer 30 pF long ¾in. spindle. **2/3** each or **24/-** per dozen.

7b. ¾in. coil former with dust core and can. **4/6** per dozen sets.

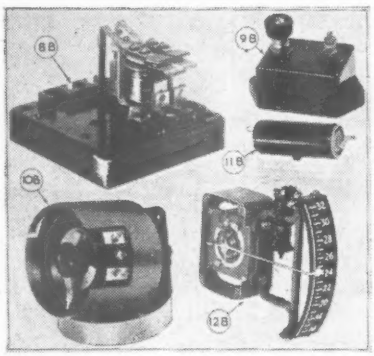
8b. Double pole contactor on bakelite case, coil resistance 100 ohms, heavy duty silver contacts. **3/6.**

9b. 500 pF. 5kV coupling condenser for transmitting, R.F., heating, etc. **3/6.** each or **36/-** per dozen.

10b. Precision Pot/meter 25,000 ohms 50 watt, in plated can with back cover, front escutchion and instrument knob. **25/-** each.

11b. Bakelite cased condenser. .01 mFd. 4 kV., **1/9** each or **18/-** per dozen.

12b. Edgwise moving coil, movement easily converted for horizontal working. Length of pointer 4in. from centre, overall dimensions approx. 4½in. × 4½in. × 1½in. Full-scale deflection approx. 10 mA. **35/-** each.

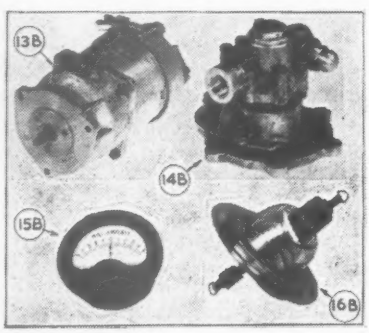


13b. Heavy duty 24 v. D.C. motor, length 7¼in., diameter 3¼in. **27/6** plus 2/6 post.

14b. Heavy duty gear pump, will build up tremendous pressure for hydraulic lifts etc. **27/6.** Post 2/6.

15b. 2½in. flush mounting moving coil meter 250-0-250 microamp, centre zero. **27/6.**

16b. Pyrex glass through panel insulator, coupler with metal fixing flange. **2/6.**

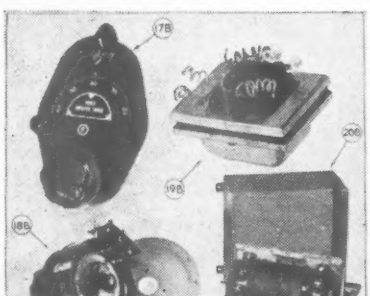


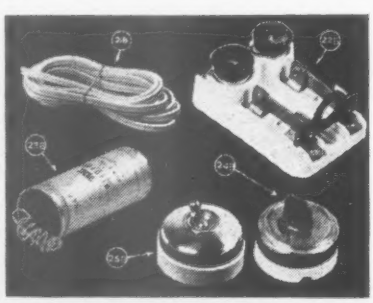
17b. Heavy-duty slow-motion drive — ex-American transmitter, main and vernier scales. **15/-.**

18b. 20K precision pot/meter 10-20 watt with instrument knob and graduated metal scale. **12/6.**

19b. Half-shrouded drop-through mains transformer, standard 50 cycles, tapped primary, H.T. secondary 250-0-250 at 60-80 mA. L.T. secondary 6.3 volts 2 amp. **15/-** plus 2/6 post.

20b. D.C. Rotary Converter. Doubles or halves voltage, e.g. 24v. to 12v. or vice versa, **45/-,** plus 3/6 carriage and insurance.





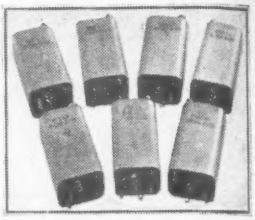
21b. 6ft. unbreakable mains lead, can be kinked, twisted and knotted indefinitely. Ideal meter lead. Normally 2/- per yard—**1/-** per lead or **10/-** per dozen.

22b. 30 amp. fused knife switch for overhead cables, etc. **3.6** each.

23b. High voltage metal cased condenser, upright mounting, .1 mF + .1 mF at 3.5 kV. **6/6.**

24b. Series parallel (2 way and off) tumbler switch. Crabtree. **1/3** each, or **13/6** per dozen.

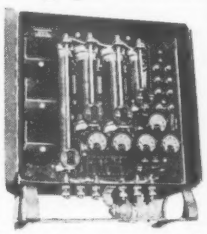
25b. 5 amp. Rotary Switch, has on and off indicator. **2/-** each or **21/-** per dozen.



SET OF I.F. TRANSFORMERS

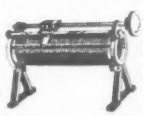
465 kc/s for communications receiver, first-class American manufacture, **19/6** the set.

Charging Switchboard

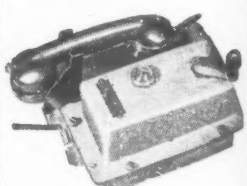


Offered at about one twentieth of original cost. This is an ex Government switchboard. It contains three reverse current relays, one voltmeter, one main ammeter, two secondary ammeters and three variable resistors for controlling circuits. These are original cases. Price **£2/15/-.** Carr. 10/-.

Variable Rheostat



This is a heavy duty slider resistor rated at 25 amps. but easily capable of twice this load. Basic resistance is 4 ohms but by the removal of one wire this becomes .8 ohms. Alternatively it can be rewired to suit individual requirements. Adjustment is by rotating a Bakelite knob which couples to a heavy duty slider, ideal for dimmer circuit. Price **8/6,** post and ins. 3/6.



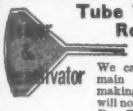
Sound Powered Telephone

These require no batteries and will go for long periods without attention. Complete with generator and sounder which gives a high pitched note easily heard above any other noise. Also fitted with an indicator lamp which in quiet situations can be used instead of the sounder or where several telephones are used together, will indicate which one is being called. Size 7½ × 9 × 7½in., wall mounting, designed for ships' use but equally suitable for home, office, warehouse, factory, garage, etc. Price **57/6** each, plus 4/6 carriage.

E.S. Lampholder

panel mounting bakelite, insulated **2/-.**

Tube Tester and Re-Activator



We can supply all the main components for making this unit which will not only test Cathode Ray Tubes but also will re-activate them, supplied complete with full instructions. Price **£3**, plus 2/6 post and ins.

Transistor Timer

All the parts for making transistorised Enlarging or Process Timer with constructional details. **£2/10/-**, plus 2/6 post and pkg.

Beginner's Superhet

All the components including metal chassis, valves, metal rectifier, coils, tuning condenser, etc., etc. required to build the "Beginner's Superhet" as described in the January issue, are available as a parcel. Price **£3**, plus 3/- post and ins.

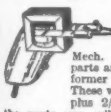
Condenser Tester and Re-Activator

This unit tests condensers under correct working conditions at proper voltages, it can also be used for "reforming" electrolytics. All basic parts and full instructions, **50/-**, plus 2/6 post and ins.

Band III Converter

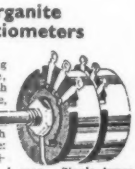
Suitable Wales, London, Midlands North, Scotland etc. All the parts including 2 EF90 valves, coils, fine tuner, contrast control, condensers, and resistors. (Metal case available as an extra.) Price only **19/6**, plus 2/6 post and insurance. Data free with parts or available separately **1/6**.

Making a Solder Gun



A 7-second solder gun of the type costing £3-4-4 was described in Prac. Mech. Only two essential parts are required—(a) transformer and (b) push switch. These we can supply at **13/6**, plus 2/- post. The rest of the parts you will have in your own "junk" box. Copy of the article concerned given free with the kit.

Morganite Potentiometers

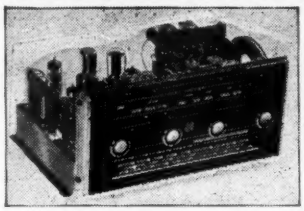


Single and 2 gang types available, standard size with good length spindle, and new and boxed gang type **3/-** each —values available: 5K + 5K, 100K + 100K, ½ meg. + ½ meg. Single types **1/-** each, values available: 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg.

Vacuum Pump

Rotary vane type. Spline drive shaft—threaded inlet and outlet, also makes good compressor. Price **22/6**, plus 2/6 post and packing.

AM/FM Chassis



made by the famous McCarthy Radio. This employs a printed circuit in the F.M. Tuner section, it uses 8 valves and has a very attractive three colour dial, size approximately 12 × 5½in., covers four wavebands: 1000-2000 m., 200-550 m. 15-50 m., and 88-100 mc/s. This is a precision made chassis with four controls, tuner, volume, wavechange and tone. Fully guar. Price **£22/10/-**, post and ins. 5/-.

TAPE DECK SNIP—LAST CHANCE

TAPE DECK—Made by the famous Truvox Company. This contains exactly the same essentials as the current model. Only the styling is different. It also takes the stereophonic head.

SPECIFICATION: 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. Push button controls, electrically and mechanically interlocked. Patented electric type push button controlled brake. Tape loading on the drop in principle, accommodation for reels of 7in. diameter. Tracking sense to British and American standards. Playing times: up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. Two tracks side by side with safety gap. Positive Azimuth adjustment of Record/Player head. High Impedance Heads. Overall size 14½ × 12½ × 5in. approx. 120 only of these fine decks offered at non-repeatable price of **£17/10/-**. Non-callers add 10/- carriage and ins.

"THE CRISPIAN" BATTERY PORTABLE

A 4-valve truly portable battery set with very many good features as follows:—

- **Ferrite Rod Aerial.**
- **Low consumption valves (DK96 range).**
- **Superhet circuit with A.V.C.**
- **Ready built and aligned chassis if required.**
- **Beautiful two-tone cabinet.**
- **Guaranteed results on long and medium waves anywhere.**

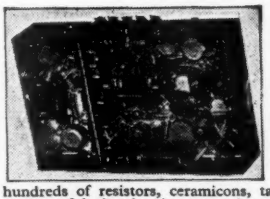
All parts, including speaker and cabinet, are available separately or if all ordered together the price is **£7/15/-** complete, **£1/15/-** deposit and seven monthly payments of **£1**. Post and insurance 3/6. Ready built chassis **30/-** extra. Instruction booklet free with parts or available separately **1/6**.

Entirely Redesigned A.C./D.C. Multimeter Kit

15 Basic Ranges

Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions, price 19/6 plus 2/6 post and insurance.

THIS MONTH'S SNIP



is a 16 valve American made chassis, less valves but containing a multitude of very useful parts. To mention a few of these there are: 2 miniature relays and 1 standard relay, 2 variable inductors, 5 pots with locks, 5 mansbridge condensers, 8 high stab. resistors, 24 mica condensers, 5 single point sockets and literally hundreds of resistors, ceramicons, tag panels, etc., etc., also a most useful chassis, size approximately 10 × 6 × 2in., price only **10/-**, post free.

Ceramic Switches

By one of our best makers, 3 pole, 3 way, **2/6** each, also standard type switches 12 pole, 2 way, **1/3** each, 6 pole 3 way **1/3** each, 2 pole, 6 way **1/6** each.

Thermal Delay Vacuum Relay

This can be the basis of a process timer—plastic sealer controller. Sequence switching—infra red indicator—overload protection. Our booklet free with the relay or separately 1/6, gives suggested circuits. Hermetically sealed with 4-pin base, heater resistance approx. 1,500 ohms. This can be used for overload protection. Approximately 17 milliamps through the heater coil will cause the contacts to close. Limited quantity—**8/6** each, post and insurance 1/6.

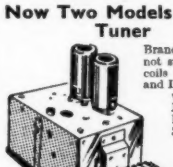
"Sniperscope" 5/- only.

"Cats eye" used for seeing in the dark. Will work burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Price **5/-** each. Post and ins. 1/-. Data will be supplied with cells if required.

You can build our TV in one evening

There are only 24 solder joints to make —suitable 14in. or 17in. tube, cost **£29/10/-**. We will gladly send full constructional details and circuit diagram on receipt of 3/6 which will be credited in full if you buy the kit.

Now Two Models Turret Tuner



Brand new stock, not surplus, with coils for Band I and III, complete with valves. Model I.—I.F. output 33/38 mc/s. Series heaters. Model 2.—I.F. output 16-19 mc/s. Parallel heaters with instructions and circuit diagram **79/6**. With knobs **3/6** extra, post and ins. 2/6.

Hi-Fi Bargain

12in. Hi-fidelity loudspeaker. High Flux Permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new by famous maker. Price **32/6**, plus 2/6 post and insurance.

ELECTRONIC PRECISION EQUIPMENT, LTD.

Post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 2.

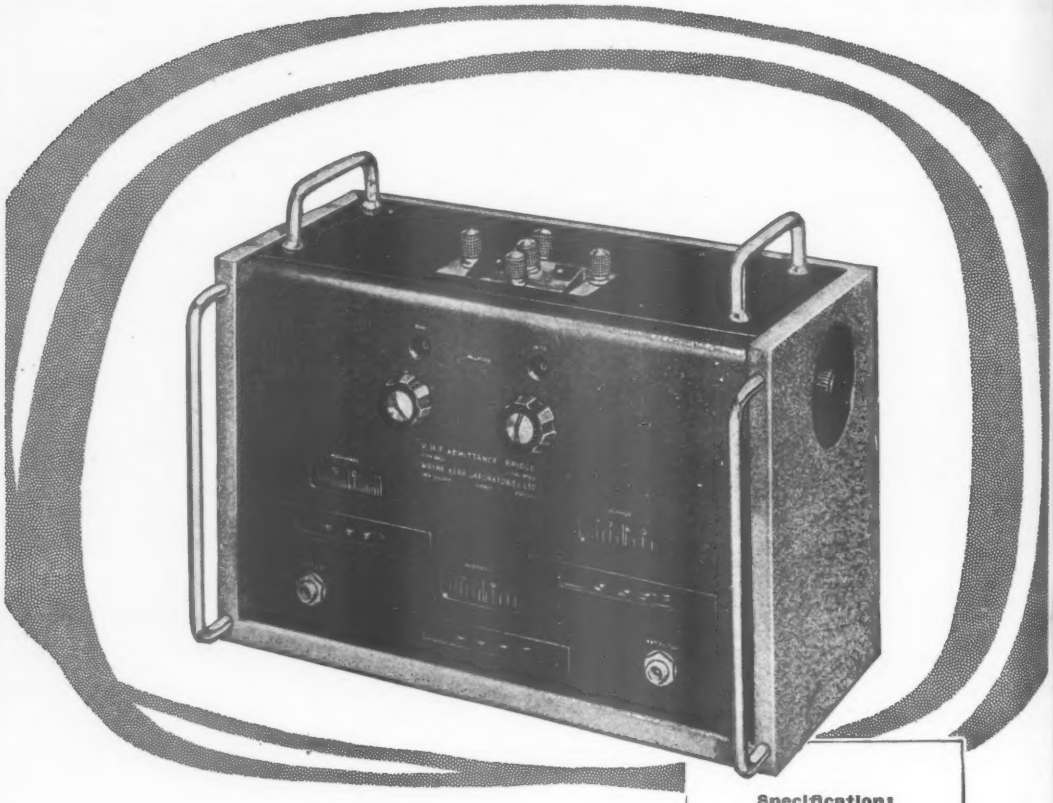
42-46, Windmill Hill, Ruislip, Middx.
Phone: RUISLIP 5780
Half day, Wednesday.

66, Grove Road, Eastbourne, Sussex.
Half day, Saturday.

29, Stroud Green Rd., Finsbury Park, N.4.
PHONE: ARChway 1049
Half day, Thursday.

266, London Road, Croydon.
Phone: CRO 6558.
Half day, Wednesday.

XUM



V.H.F. BRIDGE TYPE B.801

An extremely stable transformer ratio-arm bridge designed for aerial, feeder, cable and component measurements, balanced or unbalanced, at frequencies between 1 and 100 Mc/s.

Calibration, which is independent of frequency, is in terms of conductance and positive or negative capacitance.

Specially designed source and detector are available.

Specification:

Frequency range:
1 to 100 Mc/s

Susceptance range:
±230 pF

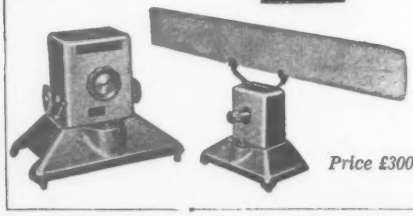
Accuracy: ±2% ±0.5 pF

Conductance range:
0 to 100 mmho

Accuracy: ±2% ±0.1 mmho

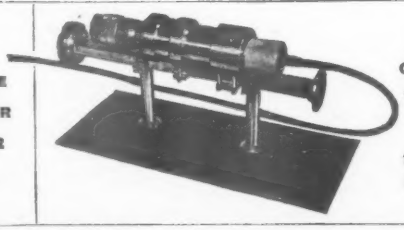
Price: £165

WAYNE KERR



X-BAND MICROWAVE WATTMETER TYPE U.182

Price £300 net ex works



X-BAND OSCILLATOR TYPE S.381

Price £150 net ex works (valve extra)

DETAILS OF FULL RANGE FROM: THE WAYNE KERR LABORATORIES LTD., ROEBUCK RD., CHESSINGTON, SURREY. LOWER HOOK 1131

SenTerCel

SILICON ZENER DIODES

Z 2 SERIES

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HAVE A LARGE DISSIPATION FOR THEIR SIZE

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ARE SUITABLE FOR HIGH TEMPERATURE OPERATION

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HAVE A LOW TEMPERATURE CO-EFFICIENT OF VOLTAGE

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ACTUAL SIZE

± 20% VOLTAGE RANGE					
ZENER DIODE TYPE	Z2A33	Z2A47	Z2A68	Z2A100	Z2A150
NOMINAL VOLTAGE	3·3	4·7	6·8	10·0	15·0

COMPONENTS STC GROUP

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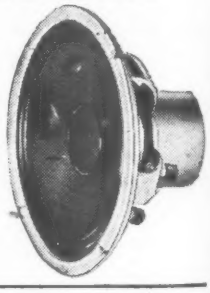
PERIPHONIC

the new G.E.C. loudspeaker system that cancels distortion

At 40 cycles per second with 10 watts input, the Periphonic system reduces harmonic distortion to the incredibly low figure of 2.7%. At 1000 C.P.S. and under the same full power conditions the distortion is 0.3%. Here, truly, is a masterpiece . . . a magnificent triumph in sound reproduction that could never have been achieved without the two "air-coupled" G.E.C. metal cone loudspeakers and the four G.E.C. presence units which are mounted in a specially constructed cabinet embodying entirely new principles.

Exclusive to the G.E.C. and *available as individual units*, the metal cone loudspeakers give low inter-modulation distortion, extremely smooth high frequency response and excellent transient response. Designed as accessories to the loudspeakers, the presence units overcome point sound source and add "presence" to the 9 octave realism. Also available are G.E.C. pre-amplifiers and amplifiers that take full advantage of all the inherent qualities of this exceptional sound equipment.



GEC metal cone loudspeaker

GEC presence unit

G.E.C. HIGH QUALITY SOUND EQUIPMENT

Metal Cone Loudspeakers * Presence Units * Stereophonic Systems
Periphonic Loudspeaker Systems * Pre-amplifiers * Amplifiers

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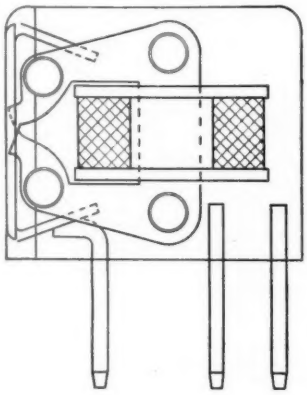
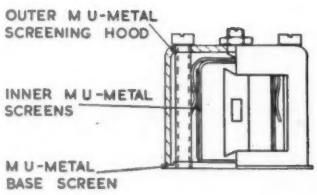
WHAT MAKES A GOOD TAPE RECORDER?

Coping with THE PRICE ON YOUR HEAD

Perhaps the most critical single electronic component of a tape recorder is its magnetic transducer, or as it is often called, the Recording Reproducing Head. Upon its sensitivity and its consistent performance much depends.

The Recording Reproducing Head used in Grundig Tape Recorders employs an unusual form of construction lending itself to an efficient and compact unit. The production techniques employed permit a rigid specification and despite the fact that the manufacturing technique must be controlled to extremely fine limits, all factors concerned with the production of Grundig Heads are so stringently controlled that mass production is possible. It is well known that the term "mass production" applied in its widest sense, means the most economical selling price.





TECHNICAL SPECIFICATION

Inductance	550mH
D.C. Resistance	550hms.
Optimum Bias for Grundig Tapes	1mA.
Frequency Response, obtainable with suitable equalisation	30—16,000 c.p.s.
Gap Width	0.00023"
Shim Material	Gold Foil
Size	$\frac{3}{4}$" x $\frac{5}{8}$" x $\frac{7}{16}$"
Mounting	Plug-in

In order to minimise hum pick-up through the Recording Reproducing Head, efficient screening methods are employed which are shown in the accompanying diagram.

GRUNDIG

Makers of the finest Tape Recorders in the world

GRUNDIG (Great Britain) LTD.

39/41 NEW OXFORD STREET, LONDON, W.C.1

(Electronics Division, Gas Purification & Chemical Co. Limited)

GS 97

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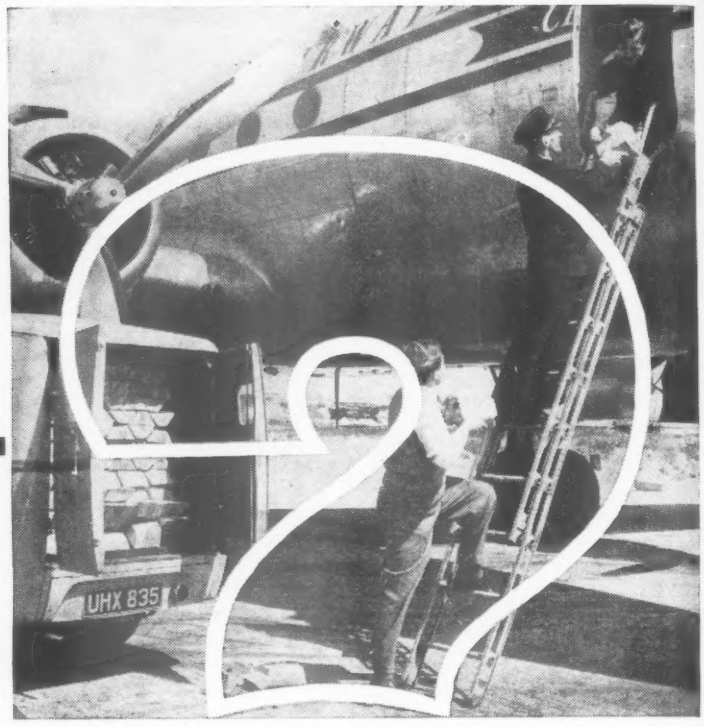
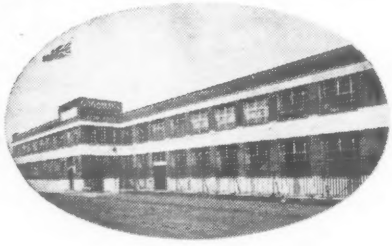
Do you know...



that Goodmans Industries,



Limited,

have the largest and most modern Loudspeaker manufacturing plant in Europe?

have the most up-to-date Loudspeaker laboratory in Great Britain?

are the largest manufacturers of High Fidelity Loudspeakers in Europe, and the largest Exporters of High Fidelity Loudspeakers in the World?

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new AXIOM loudspeakers
see next month's issue for full details.

GOODMANS

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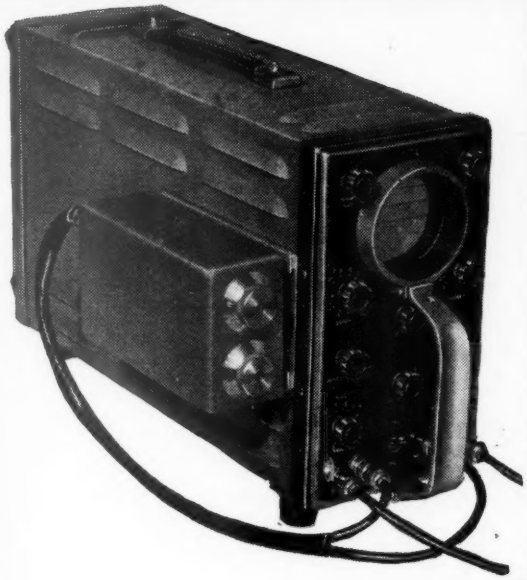

TYPE 3EG1

The Kelvin and Hughes Mk V Flaw Detector with High Power Transmitter* uses a 'Cintel' Cathode Ray Tube. This tube is but one from a wide range manufactured for instrument applications and instrumentation is only one of the many fields covered by the 'Cintel' catalogue.

**Photograph by courtesy of Kelvin & Hughes Ltd.*

INSTRUMENT TUBES

✻ **over 200 tube types in the current catalogue. Full data on request.**

WORSLEY BRIDGE ROAD
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A Company within the Rank Organisation Ltd. **HITHER GREEN 4600**

CINTEL

Newmarket Transistors

GOLTOP 10 WATT POWER TRANSISTORS

TYPE V30/10LP

Available NOW

PRICE 25/- EACH

NET RETAIL

Recommended Maximum ratings (t_{amb}=25°C)

Collector Voltage (V_c) D.C. or peak .. .. −30V
Collector Current (I_c) D.C. or mean .. .. −3.0A

Characteristics

(V_c=−1.5V, t_{amb}=25°C, f=1 kc/s)

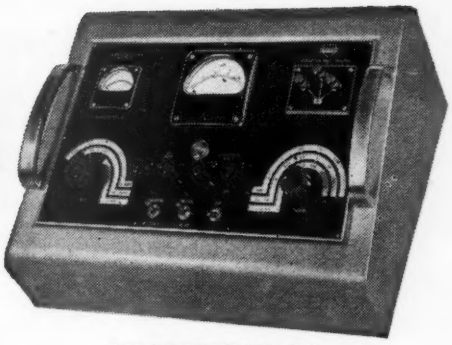
Collector cut off current I_{co} 30μA
Current gain (alpha) .. .. I_c−200mA 0.947
„ „ (beta) .. .. I_c−200mA 10 min.
Input Resistance with R_{load} = 20 ohms .. .. I_c−200mA 20 ohms
Output Resistance with R_{gen} = 50 ohms .. .. I_c−200mA 425 ohms

Maximum Collector Power Dissipation

At t_{amb}=25°C with the transistor clamped directly on to 50 sq. in. of 16 S.W.G. aluminium, max. power dissipation is 10 watts. Clamped directly to 9 sq. in. of 16 S.W.G. aluminium, it is 4 watts. Transistor only in free air, 1 watt. Reductions of maximum power of 200mW, 80mW and 20mW respectively, are necessary for every °C rise of the ambient above 25°C.

NEWMARKET TRANSISTOR CO. LTD.
Exning Road, Newmarket Telephone: Newmarket 3381/4

COMPACT TRANSISTOR TESTER



With the L264, design engineers can check instantly the characteristics of transistors and establish their working parameters.

- ✳ Current gain (A′) in grounded emitter connection.
- ✳ Collector current (1′c(0)) with zero base current.
- ✳ Collector turnover voltage

SPECIFICATION

Current gain (A′)
Ranges 0–100, 0–200 } accuracy ± 7%
Collector current (1′c(0))
Range 0–2.5A accuracy ± 7%
(collector voltage ranges nominally available 0–3V and 0–30V, reduced when using higher collector currents)
Collector turnover voltage
Range 0–85V
Mains input 200–250V 40 to 60c/s. Consumption approximately 15W.

IMPORTANT NEWS for designers of transistorised equipment

The L280 is the first mains operated power source developed specifically for use with transistors.

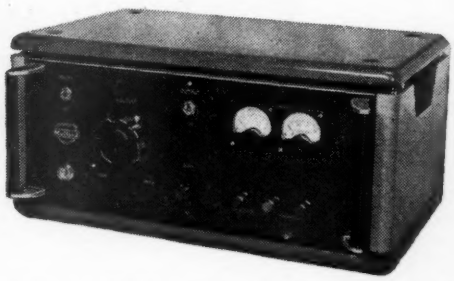
It provides designers with the most convenient source of power for transistors yet developed.

- ✳ Transistorised—for long life
- ✳ Mains operated—obviating battery troubles
- ✳ Fully stabilised—against load and input fluctuations

SPECIFICATION

D.C. output voltage 0–30V continuously variable
Output current 0–1A output voltage variation less than 40mV over complete range
Regulation < 60mV for mains input fluctuations of ± 10V < 200mV for ambient temperature fluctuations 20–50°C
Response time 1 millisecond
Output resistance < 0.05Ω at D.C.
< 0.2Ω all frequencies up to 100k/cs
Residual ripple 1mV under worst conditions
Isolation from earth and mains up to 500V. d.c. up to 250V. a.c.
Mains input 200–250V 40 to 60c/s. Consumption approximately 60W

UNIQUE TRANSISTOR POWER SOURCE



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Equipment Division • Mullard House • Torrington Place • London • W.C.1 • Tel: LANgham 6633

ME621

PAINTON

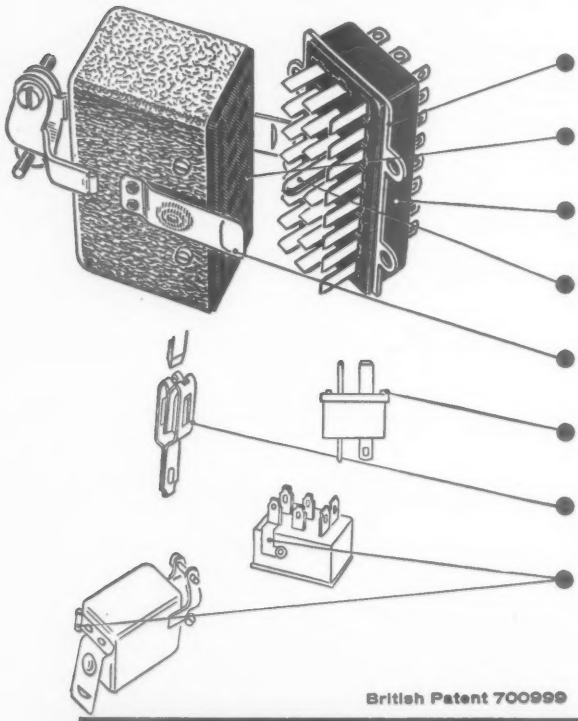
"MULTICON" PLUGS AND SOCKETS

The full range consists of 2, 4, 6, 8, 10, 12, 18, 24 and 33-pole sizes. Illustrated is the 24-pole size.

Working voltage: 1,000 volts D.C. or A.C. (peak) or 500 volts D.C. or A.C. (peak) in tropical use.

Current rating: 5 amps. D.C. or A.C. (R.M.S.) per contact.

Average contact resistance: below 0·002 ohms.



Metal flanges moulded into the body to ensure flush mounting and to avoid alignment difficulties.

Terminal numbering moulded into plug and socket bodies to facilitate wiring and cableform testing.

Single-piece nylon-filled body mouldings provide high insulation and tracking resistance.

Large pin locator contact facilitates engagement, especially in unitor applications.

Optional vibration-proof retaining blades to secure the unit to panel or chassis.

Four distance pips keep mating faces apart and eliminate moisture traps between plug and socket faces.

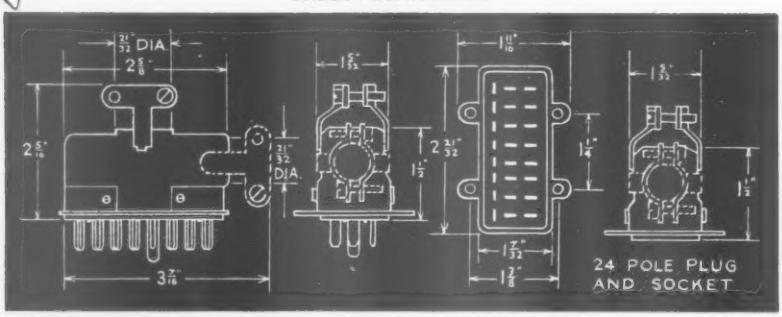
Socket clips have split limbs with four areas in contact with each plug blade ensuring absolute reliability of contact.

Earthing of plug or socket covers is achieved by either:

internal connecting link from a contact to cover, OR

rivetted earth tag to outside of cover.

British Patent 700999



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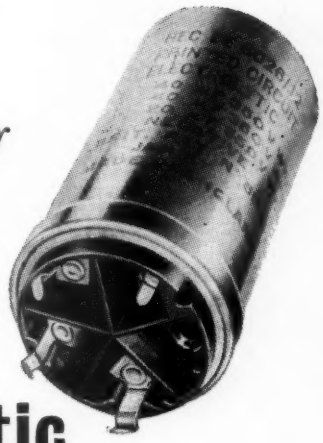
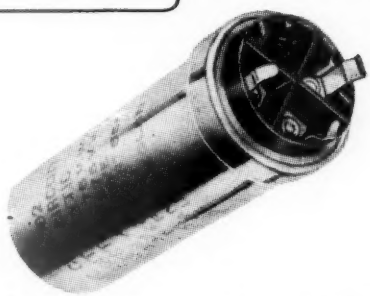
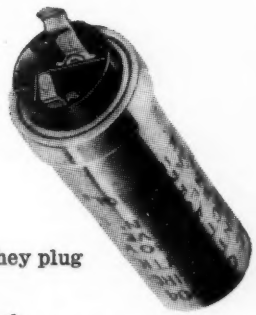
Especially designed for printed circuits...



Plessey Electrolytic Capacitors





A special range of Plessey electrolytic capacitors is now available for vertical mounting in printed circuits. They plug directly into panels and the protruding tags do not require forming or bending but simply snap into the pierced holes and force the soldering surface into direct contact with the printed copper wiring. Due to the unique design of these capacitors, it is impossible to bridge the contacts during soldering operations. Mounting is foolproof and extremely simple because of the special tag arrangement. Soldering and removal of units is easily achieved without disturbing associated components or causing inadvertent damage. Produced for either manual or automatic insertion, printed circuit capacitors by Plessey are supplied in three different can dimensions : ¾", 1" and 1¼" diameters.

Those interested in the application of these outstanding components should request a copy of Plessey Publication No. 908.

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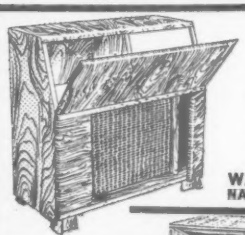


THE BUREAU

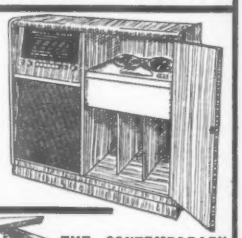
This popular bureau cabinet is veneered with the finest selected Walnut and beautifully polished in a medium shade. Designed to accommodate almost any of the many units we have available and to give generous storage compartments.

WALNUT £16 . 16 . 0
NATURAL OAK £18.18.0

"PRELUDE"

This most attractive cabinet has been designed to utilise natural acoustic properties of the walls, and is ideal where space saving is a consideration.
Will take 8in. or 10in. speaker unit with provision for Tweeter Unit (12in. cabinet also available).

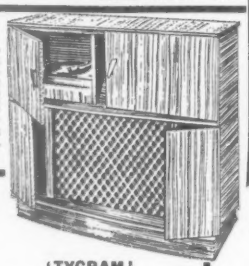
£10 . 10 . 10



THE SERENADE

Veneered with finest selected walnut, beautifully polished to a medium shade; this attractive cabinet has generous storage space, with board sliding out smoothly on metal rollers.
This cabinet can be fitted with any of the latest Hi-Fi Units.

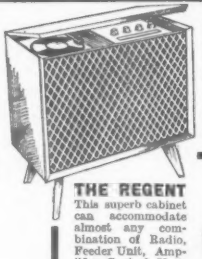
£12 . 19 . 6



THE CONTINENTAL

This elegant Cabinet is the latest in our range designed in the continental style, solidly constructed and finished in selected mahogany veneers. Available medium, light, high gloss or contemporary finish.

£29 . 10 . 0



THE CONTEMPORARY

This beautifully made cabinet is oak veneered with mahogany interior and is waxed finished. Available in any shade to order at slightly extra cost.
This cabinet can be fitted with any of the latest Hi-Fi Units.

£10 . 15 . 0

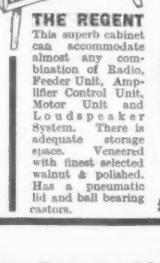
'TYGRAM'

This smart-looking cabinet is available with or without legs. Can accommodate any type of turntable (including transcription or autochanger units).
The unit also accommodates any type of amplifier, plus most radio tuners.

9 gns.
without legs **£7 . 14 . 0**

WE ALSO CARRY A LARGE RANGE OF EQUIPMENT
See Page 78

We supply all units and can fit any cabinet with the latest Hi-Fi amplifiers, tuners, transcription units, record changers, speakers, etc. Send for comprehensive illustrated catalogue of cabinets, autochangers, speakers, etc., all available on easy H.P. terms.



THE REGENT

This superb cabinet can accommodate almost any combination of Radio, Feeder Unit, Amplifier Control Unit, Motor Unit and Loudspeaker System. There is adequate storage space. Veneered with finest selected walnut & polished. Has a pneumatic lid and ball bearing castors.

£22 . 10 . 0

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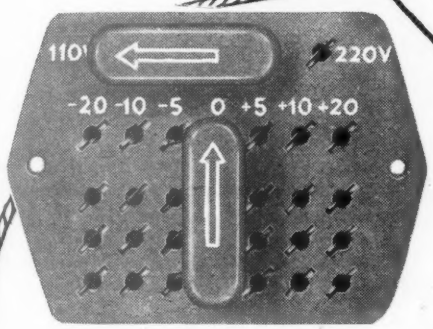
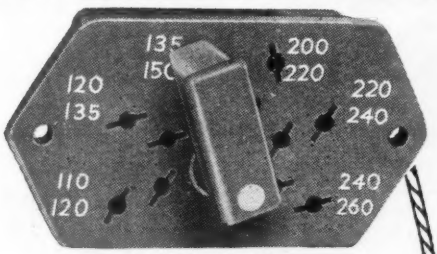


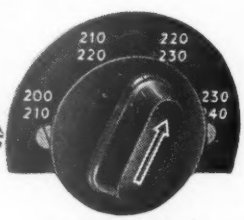
3 Pin Shorting Plugs

6 WAY
Type XVS/6
NYLON LOADED P.F. MOULDING



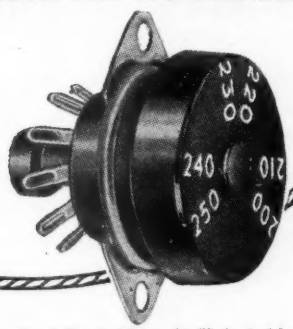
3 Pin Shorting Plug

4 WAY
Type BVS/4
BLACK P.F. MOULDING



3 Pin Shorting Plug

6 WAY MINIATURE
Type BMVS/6
BLACK P.F. MOULDING



Standard B9A (Noval) Valveholder with 2 Pin Captive Shorting Plug

Send for full details to :—

THE McMURDO INSTRUMENT CO. LTD., ASHTEAD, SURREY. Tel: ASHTEAD 3401

MVS15

We offer a complete Tape Recorder Service

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Vortexion 2A	88 gns.
Brenell Mk. 4	53 gns.
Elon	62 gns.
Grundig TK5	53 gns. inc. mic.
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Grundig TK830	100 gns. ex. mic.
Elizabethan Essex	65 gns.
Magnafon FRS	55 gns.
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Philips AG 8109	39 gns.
Philips AG 8108	62 gns.

VORTEXION TAPE RECORDER
Model 2B

This has synchronous capstan motor with provision for 1,750 ft. reels of tape or 2,625 ft. of thin tape. Improved heads give a response to over 7,000 cps at 3¾" per sec. resulting in a 4½ hours recording to be made on one reel of tape.

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Scotch Boy	
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We stock all the leading makes of amplifiers, control units, transcription units, pickups, loudspeakers and FM Tuner units.

PROMPT ATTENTION GIVEN TO POST ORDERS
EXPORT INQUIRIES INVITED AND WELCOMED

THE WEYRAD AM/FM RECEIVER

THIS RECEIVER WHICH HAS BEEN SPECIALLY DEVELOPED FOR THE AMATEUR CONSTRUCTOR PROVIDES COMPLETE COVERAGE OF THE SOUND BROADCAST BANDS—LONG, MEDIUM AND SHORT WAVE AM. WITH 87.5-100 Mc/s. V.H.F. FOR FM. WE HAVE PRODUCED A FULLY ILLUSTRATED BOOKLET WHICH GIVES INFORMATION ON THE ASSEMBLY AND ALIGNMENT OF THE 4-BAND SEVEN-VALVE RECEIVER, INCLUDING CHASSIS LAYOUT, CIRCUITS AND POINT-TO-POINT WIRING DIAGRAM.

★ " WEYRAD " B.61 COIL PACK, P.23 I.F. TRANSFORMERS, T.S.61 TUNING SCALE, Q2 I.F. FILTER, E.822 MAINS TRANSFORMER AND E.823 OUTPUT TRANSFORMER.

★ ALUMINIUM CHASSIS WITH ALL PUNCHING AND BENDING COMPLETE.

★ DESIGNED FOR LATEST TYPE MULLARD VALVES.

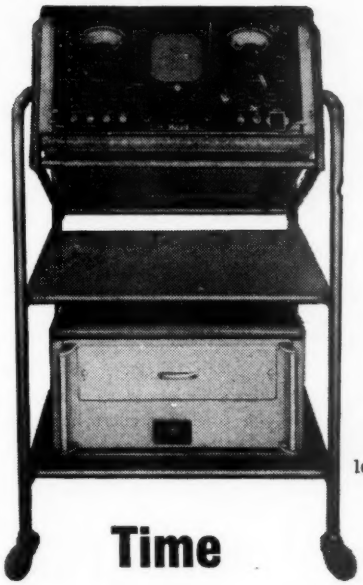
★ RECEIVER OUTPUT CAN BE MODIFIED FOR USE AS A RADIO FEEDER FOR QUALITY AMPLIFIERS.

THE BOOKLET & PRICE LIST ..... **2/6d.**

ILLUSTRATED FOLDER OF A.M. COMPONENTS..... **3d.**

WEYMOUTH RADIO MANUFACTURING CO., LTD.

CRESCENT STREET, WEYMOUTH, DORSET



Time and voltage measuring accuracy 3%

MULLARD single beam Precision Oscilloscope type L.140 is an invaluable aid to engineers working in pulse circuitry, where the measurement of pulse amplitude and duration is required to an exceptional degree of accuracy. Unique circuitry and the use of large illuminated scales enables these quantities to be measured with an accuracy of 3%.

The "Y" amplifier, comprising a main and pre-amplifier, can be switched to provide both A.C. and D.C. coupling facilities, whilst a probe ensures that the circuit measured is not unduly loaded.

The triggered time-base has a rapid start and exceptional linearity throughout its sweep.

When the oscilloscope is triggered by randomly spaced pulses, the leading edge can be clearly observed and measured with accuracy.

To preserve the high measuring accuracy, considerable attention has been paid to stabilising the separate power supply. Mains voltage fluctuations up to ± 7% do not affect the performance of the instrument.

Both the display unit and the power supply are normally supplied in metal cabinets, suitable for bench or trolley mounting. The front panel and chassis assemblies, however, have been so constructed that they will fit conveniently into a standard 19" rack.

ABRIDGED SPECIFICATION

TIME BASE

Triggered, free running, or synchronised.

Sweep duration	5μsec. to 150 msec. in 10 ranges.
Sweep length	Constant on all ranges, can be expanded up to 5 screen diameters.
Time measurement ranges	0–5 μsec., 0–15 μsec., 0–50 μsec., etc. to 150 msec.
Trigger input impedance	1MΩ + 25 pF, alternatively 10 MΩ + 10 pF.
"X" amplifier sensitivity	1.2V pk-pk/cm to 6V pk-pk/cm.
Bandwidth	1 c/s–2 Mc/s (70% response)
Input impedance	1 MΩ + 30 pF.

'Y' AMPLIFIER

	Main Amplifier only	*With Pre-amplifier*
Maximum sensitivity ...	150 mV pk-pk/cm	4.5 mV pk-pk/cm
Maximum bandwidth ...	D.C. to 7.5 Mc/s (70% resp.)	1c/s to 6Mc/s (70% resp.)
	D.C. to 13 Mc/s (30% resp.)	0.7c/s to 10Mc/s (30% resp.)
Rise time... ...	0.05 μsec.	0.05 μsec.

Input impedance... 400-600 KΩ + 25 pF. (D.C. range) 400 KΩ + 45 pF. (A.C. range)

Voltage measurement ranges ... ... } 0–30 mV, 0–100 mV, 0–300 mV, etc. to 0–300 V.

Signal delay ... ... 0.6 μsec. (switchable).

CATHODE RAY TUBE

Mullard type DG13-34/5ADP1, incorporating post deflection acceleration (switched)

Diameter	13 cm, masked to 9.4 cm square.
Screen	Blue-green medium persistence phosphor.

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SPECIALISED ELECTRONIC EQUIPMENT

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TORRINGTON PLACE
LONDON WC1
TEL: LANgham 6633
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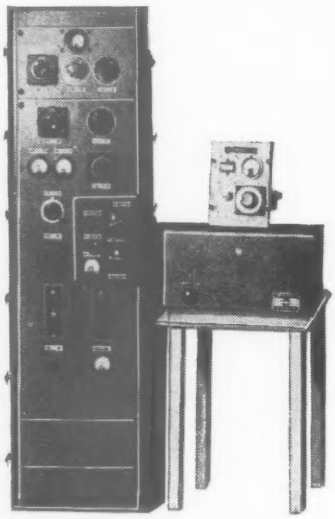
FAMOUS RCA TRANSMITTERS TYPES ET 4336, K & L



Frequency 2 mc.-20 mc.
Power output: 350 w. telegraph.
250 w. telephone.
Type of modulation—Class B high level.
Audio input impedance 500 ohms.
Power supply 190 to 250 v. single phase 50-60 c.
Tube complement: Crystal oscillators—807, Master oscillators—807, Intermediate amplifier—807, Power amplifier—813(2), Modulator—805(2), Rectifier—866A(4).
Complete with Master Oscillators, crystal multipliers, speech amplifiers, microphones, keys, instruction manual, etc.
We guarantee full supply of all replacement parts for a minimum of 5 years after purchase.

P.C.A. RADIO

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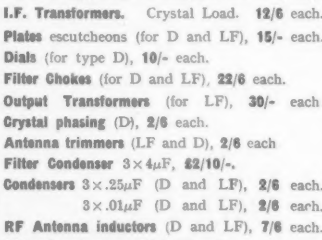
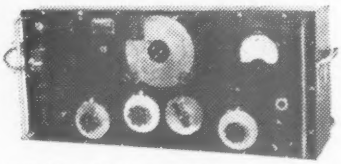
Telephone: RIV 8006/7

BRAND NEW ORIGINAL SPARE PARTS FOR ARB8 RECEIVERS.

I.F. TRANSFORMERS 1st, 2nd, 3rd, 4th (for type D) **12/6** each or complete set of 6, **60/-.**
I.F. Transformers. Crystal Load. **12/6** each.
Plates escutcheons (for D and LF), **15/-** each.
Dials (for type D), **10/-** each.
Filter Chokes (for D and LF), **22/6** each.
Output Transformers (for LF), **30/-** each
Crystal phasing (D), **2/6** each.
Antenna trimmers (LF and D), **2/6** each
Filter Condenser 3×4μF, **£2/10/-.**
Condensers 3×.25μF (D and LF), **2/6** each.
3×.01μF (D and LF), **2/6** each.
RF Antenna inductors (D and LF), **7/6** each.
Mains transformers (LF), **£3** each.
Small knobs (for LF and D), **4/-** each.



AVOMINORS in leather case, with leads, fully tested, **£5/10/-.** Packing and Carriage 2/6.



MARCONI SIGNAL GENERATOR. T.F.144G. Covering 85 kc/s. to 25 Mc/s. Calibrated and fully guaranteed. Postage and packing 20/-. **£70.**

2 K.V.A. TRANSFORMERS. 230/50 v. output adjustable by rotary switch. Can be easily adapted as a welding transformer. **£15.** Postage and packing 30/-.

R.109A RECEIVERS. Covering 2-12 Mc/s. 6 v. D.C. **£4/5/-.** Carriage paid.

HIGH RESISTANCE HEADPHONES. 4,000 ohms. Brand New, Ex W.D., boxed, Type D.H.R., **11/-** per pair postage 1/6.

LOW RESISTANCE HEADPHONES. Brand new, Ex W.D., boxed, Type C.L.R. and D.L.R., **5/6** per pair, postage 1/6.

813 (RCA) VALVE. New, originally boxed with guarantee, **£4** each, post paid.

MODULATION TRANSFORMERS (U.S.A., Collins), primary imp. 6,000 ohms. C.T., Secondary 6,000 ohms., 20W., **9/6** each

SPARES for AR77E. Bandspread Dia **8/-.** Clean dial window sheet **3/-.** Terminal boards **3/-** each. 10in. shaft for switch **1/-.** Band indicator shutter plate **3/6.** Each item 1/- postage.

AMERICAN VALVE TESTER Model 314. Individual lever switches for each tube element. Roll Chart for American type valves. 220/30 V. A.C. Brand new in nice wooden case with leather handles. Full instruction booklet. **£10.** Carriage 10/-.

CONDENSERS, RESISTORS, COILS, TRANSFORMERS. Very large selection in stock.

JOHNSON'S AMERICAN TRANSMITTING VARIABLE CONDENSER. 1,020pF., 3,500 volts, air gap .080. **17/6,** postage 2/6. 500pF, 3,000 volts, **10/-,** postage 2/-.

SCR522 TRANSMITTER (BC625), including all valves, **45/-,** post free.

AMERICAN HANDY TALKIE. Type B.C.611 including two operating crystals (5-6 Mc. band), **£19/10/-.** Postage and packing 10/-.

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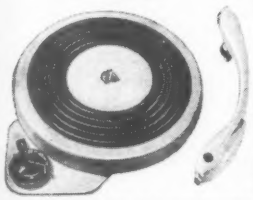
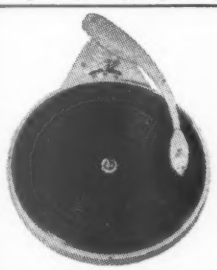
LASKY'S RADIO

SPECIAL OFFER!
COLLARO "JUNIOR" 4-SPEED MOTOR AND PICK-UP



Collaro "Junior" 4-speed motor and pick-up with HGP50 cartridge. Post 2/6. **92/6**

Motor only, **59/6**, post 2/6.
Pick-up only, **33/6**, post 2/6.



Collaro 4/564 4-speed Single Player with Studio T or O p.u. crystal cartridge and styli. Automatic stop.
LASKY'S PRICE Carr. 5/-. **£6.19.6**

AUTO-CHANGERS
See us for your requirements or send for our latest list.

COLLARO 4-SPEED MIXER AUTO-CHANGER

Latest model RC 456 incorporating auto and manual control enabling records to be played singly or automatically. Complete with Studio crystal pick-up and sapphire stylus. List £13/17/-. **£8.19.6**
LASKY'S PRICE Post 5/-.

Immediate Delivery from stock of the COLLARO 4-speed Transcription Turntable
4T200/PX **19/10/-**.
Less pick-up **14/18/-**. Carr. 7/6

BUILD YOURSELF A HIGH GRADE RECORD PLAYER!
We have the biggest selection of Auto-Changers, Single Players, Amplifiers and Cases, and you can make your own Record Player for as low as **£10**

TRANSISTORS AT A REASONABLE PRICE

R.F. P.N.P. Junction type, suitable for medium and low frequency oscillators, frequency changers and I.F. amplifiers 1.5 to 8 Mc/s (double spot—yellow & red) **21/-**

AUDIO P.N.P. Junction type, suitable for high gain and low frequency amplifiers, and for output stages up to 250 milliwatts (double spot—yellow and green). **10/-**
Post Free.

★ **TESTED AND GUARANTEED EFFICIENT**
★ **HERMETICALLY SEALED and unaffected by temperature variations.**

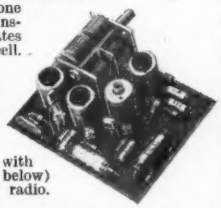
Full operating data and circuit diagrams for a simple receiver superhet, T.R.F., multi-vibrator, relaxation oscillator, audio amplifier, oscillators, signal tracers, etc., supplied with each Transistor.

MULLARD TRANSISTORS
OC70 or OC71 OC72 OC16
21/- 30/- 60/-

BRIMAR TRANSISTORS
TS1 **12/6.** TS2 **12/6.** TS3 **15/-.**
TS4 **27/6.** TP1 or TP2 **40/-.**
TJ1 **15/-.** TJ2 **16/6.** TJ3 **19/6.**

LASKY'S TRANSISTOR SUPERHET TUNER FOR HOME CONSTRUCTION ON PRINTED CIRCUIT

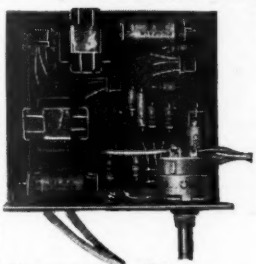
Uses three R.F. Transistors and one Germanium Diode, three I.F. transformers. Ferrite rod aerial. Operates on one 6 v. battery and one 1.5 v. cell. Printed Circuit, 3¾in. × 3½in.



CAN BE BUILT FOR. Post 3/6. **£5.12.9**
Full details and illustrations post free on request.
Demonstrations at both addresses.

NOTE:—This Tuner in conjunction with our Transistor Amplifier (see below) makes an excellent Transistorised radio. Cabinets available.

LASKY'S TRANSISTOR AMPLIFIER KIT
(200 milliwatts) For construction on a Printed Circuit



All components available separately

Size: 3⅞in. × 3½in. Height can be under 1in. Uses our new hermetically sealed Transistors and operates from 6-volt battery. Output impedance 3 ohms.

FULL DETAILS, CIRCUIT DIAGRAM AND SHOPPING LIST 1/- post free.

COMPLETE KIT including 4 Transistors, all brand new components, latest T.C.C. miniature condensers, printed circuit and full instructions, **79/6** Post 3/6.

DEMONSTRATIONS AT EITHER OF OUR ADDRESSES

SUB-MIN. TRANSISTOR TRANSFORMERS 45-1 ratio each. **4/6** Post 1/-.

ALL TRANSISTOR COMPONENTS. Trans., midget, min. and sub-min. Coils, Ferrite Rods, sub-min. Condensers, etc.

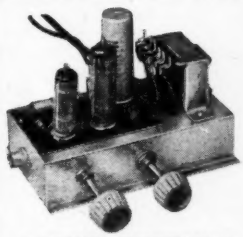
PICK-UP BARGAIN
"RONETTE" Lightweight Crystal Pick-up with 2 cartridges.
LASKY'S PRICE Post 2/6. **45/-**

CARTRIDGES
ACOS HGP37 p.u. Cartridges. l.p. and standard, complete with styli. List 41/7.
LASKY'S PRICE Post 1/-. **18/-**

Telelron "Companion"

3 - TRANSISTOR POCKET RADIO. T.R.F. circuit covering medium and long waves, with balanced armature output. Ferrite aerial. Note small size: 4¼ × 3 × 1in. You can build this novel transistorised pocket receiver for only **89/6**
Full instructions and price list, 6d. post free. All components available separately.

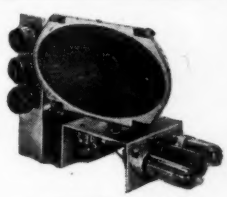
SINGLE PLAYER BARGAIN
B.S.R. TU9, 4-speed motor and latest B.S.R. "ful-fi" pick-up. **94/-**
Post 3/6.



LASKY'S PORTABLE GRAM AMPLIFIER KIT
2 watts. Note small dimensions, approx. 6½in. × 3⅞in. max., height 5in. Uses EL84 output and 6X4 rectifier, double-wound transformer, tone control, output transformer, etc. Built on a T.C.C. PRINTED CIRCUIT which greatly simplifies construction. Owing to the great demand we have been able to reduce our price.

COMPLETE KIT, including valves, printed circuit, full instructions, less Speaker. **49/6**
Carr. 2/6.

7in. × 4in. Elliptical Speaker, if required, **19/6** extra.



LASKY'S 4-WATT PORTABLE GRAM AMPLIFIER
Will suit any type of crystal or magnetic pick-up. Uses 3 valves: EL84 output, L63 and EZ80 rect. Speaker and controls are completely separate and can be mounted as shown or on anywhere in cabinet where most suitable.

COMPLETE with 3 valves and knobs, less Speaker. **79/6**
Carr. 5/-.

7in. × 4in. Elliptical Speaker, if required, **19/6** extra.

Details and circuit diagram post free on request.

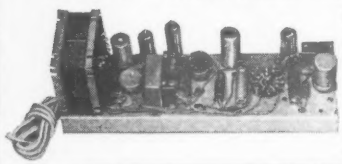
★ **H.P. TERMS AND CREDIT SALES available on certain items.**

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

LASKY'S RADIO

SAVE POUNDS! ORDER BY POST IF YOU CANNOT CALL

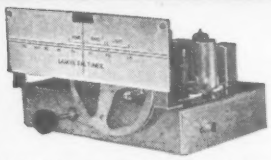
SCOOP! — PORTABLE TAPE RECORDER AMPLIFIERS



Mains 200/250 v. A.C. 6 watts output. 4 valves: EZ41 rect., EL41 output, EF40 and ECC81. Tone, volume and record/play back controls. Neon level indicator. Microphone and gram inputs. Can be used as a straight amplifier. Circuit diagram supplied.

LASKY'S PRICE **£6 . 19 . 6**

Complete with valves. Post & Pkg. 5/-.



LASKY'S F.M. TUNER

PRINTED CIRCUIT VERSION OF G.E.C. 912 "F.M. PLUS" TUNER FOR HOME CONSTRUCTION

Note these star features:—

★ HIGH SENSITIVITY.
★ ALL BRAND NEW T.C.C. CONDENSERS.
★ AERIAL COIL AND R.F. COUPLING COIL PRINTED ON CIRCUIT.
★ 5 VALVES AND 2 GERMANIUM DIODES.

By the use of a printed circuit the I.F. and R.F. Amplifiers are extremely stable at maximum gain and results are consistent on all tuners.

Valve line-up:—
R.F. Amplifier, Z719 or EF80.
Mixer and Osc. B719 or ECC85.
1st. I.F. amp., W719 or EF85.
2nd I.F. amp., W719 or EF85.
2 Germanium Diodes GEX.34.
Driver Limiter, Z719 or EF80.

Owing to the great demand we have been able to reduce our price.

CAN BE BUILT FOR (including valves) **£7 . 19 . 6**

Post and Pkg. 2/6.

G.E.C. F.M. Tuner Book plus our full data and shopping list **2/6** post free. All parts available separately.

ALIGNMENT SERVICE available.

JASON F.M. TUNER

Special Parcel containing data book, chassis, front panel, dial, drive, tuning condenser, full sets of coils, I.F.s, ratio detector, etc. **68/9**

Post 2/6.

DATA BOOK with price list **2/-**. This tuner can be built for **£6/15/-**, post 3/6.

JASON "ARGONAUT"

Super-sensitive Tuner for F.M. and medium waves. Complete parcel with power supplies. **£13.19.6**

Post 3/6.

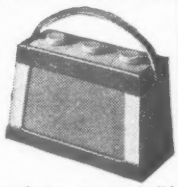
DATA BOOK **2/-** post free. Chassis Assembly **57/9**, post 2/6. I.F. and Coil Set **78/-**, post 1/6.

All components available separately.

OTHER F.M. TUNERS

TSL **£17/10/-**. DULCI **£17/10/-**. DULCI H4/T 4-wave AM/FM, **£20/17/-**. Also Quad, Leak, RCA, Rogers, Pamphonic, etc.

BUILD THIS 4-VALVE S/HET PORTABLE FOR ONLY 7 GNS.



The **PRINTED CIRCUIT** supplied makes construction amazingly easy and accurate. You can build this fine 4-valve superhet portable in an hour or so, and performance equals ready-built sets costing pounds more!

FOR ONLY £7/7/- plus 3/6 carr. and pkg., you can build this Portable using all brand new components and valves, only batteries extra. Printed circuit, circuit diagram, and full instructions supplied.

Circuit Diagram and full data 1/6 post free.

FOR ONLY £9/9/- plus 3/6 carr. and pkg., you can build this job as a mains and battery Portable using our specially designed build-it-yourself Power Unit for 200-250 v. A.C.

Brand new and unused. Overall size: 14in. long, 4½in. wide, 4½in. high. (Controls are mounted through chassis so cannot be seen in illustration.)

For use with low impedance Tape Heads.

Combined record/play/erase Head available separately, **35/-**. If purchased with Amplifier, **25/-**.

FIRST CLASS BAND III CONVERTERS AT ALMOST HALF-PRICE!

List £10.17.6

LASKY'S PRICE **£5.19.6**

Post & Pkg. 5/-.

Famous make and one of the finest Converters made. Brand new in maker's cartons. TUNABLE OVER ALL 13 CHANNELS and incorporates own power supply for 200-250 v. A.C. mains. Metal case 10in. wide, 5½in. deep, 3½in. high, smart fawn enamel finish.

Strictly limited number only. Send now for this first class Converter at bargain price.

MULLARD 510 AMPLIFIER KIT WITH T.C.C. PRINTED CIRCUIT

All specified components and your choice of transformers and chokes by Partridge, Haddon, W/B, Ellison or Gilson.

COMPLETE KIT of parts and printed circuit as low as **£9.9.0**

Details on request.

Book 3/6 post free.

Printed circuit separately 22/6.

Also available built ready for use. Price according to transformers used.

All components available separately. Price List on request.

DULCI HI-FI CHASSIS, TUNERS and AMPLIFIERS

New designs including:—

Mdl. H.3. AM/FM Radiogram Chassis, 3 wave bands including V.H.F. **£20/17/-**

Mdl. H.4. AM/FM Radiogram Chassis, 4 wavebands, including V.H.F. **£24/6/6**

Mdl. H.4.PP. AM/FM Radiogram chassis, 4 waves including V.H.F. 6-8 watts o.p. push-pull, ultra linear. **£29/3/10**

Mdl. H.11. Combined and self-powered AM/FM Tuner, Control Unit and Audio pre-amplifier. **£29/3/10**

Mdl. DPA.10. 10-14 watt Ultra Linear Power Amplifier ... **£12/12/-**

Mdl. DP.4. 4-watt High Fidelity Amplifier **£7/10/-**

HI-FI SPECIALISTS!

Selective Demonstrations of the latest Hi-Fi equipment are given at our Tottenham Court Road showrooms.

PICK - UPS. Garrard, Leak, Connoisseur, Ortophone, B/J., etc., etc.

SPEAKERS. Wharfedale, Goodmans, G.E.C., Lowther, Lorenz, etc., etc.

TRANSCRIPTION TURNTABLES. 3 and 4 speed Garrard, Connoisseur, Collaro, Lenco, etc.

AMPLIFIERS. Quad, Rogers, Leak, RCA, Pamphonic, Unitelex, W.B., etc.

CABINETS. Wide selection of Cabinets and Speaker Enclosures to house your speakers and hi-fi equipment.

NEW BRENELL MARK IV DECK

Now available! Entirely redesigned to permit of conversion to stereophonic sound with 4 heads for dual channel operation when required.

DECK only ..... **22 gns.**

DECK WITH PRE-AMP. UNIT and magic eye indicator ready for use with any standard amplifier. **38½ gns.**

COMPLETE MARK IV TAPE RECORDER, as illustrated. Counter 30/- extra ..... **53 gns.**

Come and inspect the new Brenell Mark IV and have a demonstration. Full details post free on request.

TAPE DECKS

All types in stock including the latest model COLLARO "TAPE TRANSCRIPTOR," Mk. III, fitted with digital counter, **£22.**

Carr. 21/- extra.

COLLARO TAPE PRE-AMPLIFIER, fitted and wired. **£21.**

LANE DECK **£18/10/-**

WEARITE DECKS **£35 & £40**

Carr. extra.

TAPE RECORDERS

Leading makes—Grundig, Elizabethan, Truvox, Sound, Vortexion. Also all leading makes of Tape and Spools.

COLLARO TAPE DECK MOTORS, set of 3, clockwise, anti-clock capstan. List **£5/15/-**.

LASKY'S PRICE. **95/-**

Post 5/-.

6-12 volt MINIATURE MOTORS

Complete with gearbox. Overall size. 2¾in. long × 1¼in. × 1in. Works with any voltage from 6 to 12. Ideal for models, remote control etc. Original cost over **£2.**

LASKY'S PRICE. **12/6**

Post 1/6.

MORE MONEY-SAVING LASKY BARGAINS ON NEXT PAGE

EVERYTHING FOR HOME CONSTRUCTOR & SERVICEMAN

LASKY'S RADIO

TRUVOX 'SENIOR' SPEAKER DRIVING UNIT (pressure type). Power handling cap. 15 watts peak. With 12ft. cinema horn reproduces down to 17 c.p.s.
List £7/15/-. Carr. 5/-. Lasky's Price **59/6**

MOVING COIL P.M. SPEAKERS

2½in. **17/6**. 3in. and 3½in. **19/6**
5in. **19/6**. 6½in. **17/6**. 8in. **21/-**
10in. **29/6**. 12in. **29/6**
6½in. with transformer **21/-**
7×4in. Elliptical..... **19/6**
10×7in. Elliptical **32/6**

MAGNETIC RECORDING TAPE SCOOP!

M.S.S. MASTERTAPE

On latest typeplastic spools.

Not surplus but brand new, perfect and boxed. Will work with any Recorder. Satisfaction or money back guaranteed.

1,200ft. Standard on 7in. spool, List 35/-. Lasky's Price **21/-**.

850ft. Standard on 5½in. Continental spool. List 28/-. Lasky's Price **16/6**.

600ft. Standard on 5in. spool. List 21/-. Lasky's Price **12/6**.

1,200ft. Long Play on 5½in. Continental spool. List 35/-. Lasky's Price **22/6**.

850ft. Long Play on 5in. spool. List 28/-. Lasky's Price **16/6**.

Post: 1 spool, **1/6**. 3 spools, **2/6**. 9 spools, **3/6**. 12 spools **4/-**.

HI-FI ELECTROSTATIC SPEAKERS ("TWEETERS")

LSH75 8/- | LSH518 12/6 | LSH100 14/-
LPH65 (moving coil) **39/6**.

15in. DUAL CONCENTRIC SPEAKERS

List £27/4/6. Our price **£16/19/6**.
See our February advert.

ALL-DRY POWER UNITS, 29/6
See our February advt.

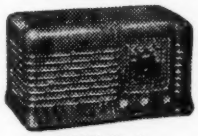
6-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

Famous Manufacturer's Surplus. 6-valve 3-wave Superhet. 13-50 m. short. 200-550 m. medium. 1,000-2,000 m. long.
LASKY'S PRICE. £10/19/6
Carriage and packing 7/6 extra.

5-VALVE RADIOGRAM CHASSIS COMPLETE WITH VALVES

3-wave superhet, 16-50 .m., 200-550 m., 1,000-2,000 m. Brand new Mullard and Mazda valves—6C9, 6F15, 6LD20, N108, U107. Overall diam. 13in. long, 6in. deep, 7in. high approx. for A.C. mains 200/250 v.
LASKY'S PRICE complete with all valves **7 GNS.**
Carr. and Pkg. 7/6 extra.
Price without valves £5/4/-

EASILY BUILT RADIO SETS



PARCEL No. 1
Contains everything to build a 4-valve 3-wave superhet for 200/250 A.C. mains. Uses 6K8, 6K7, 6Q7, 6V6 valves. Attractive wood cabinet, walnut veneer, or plastic cabinet as illustrated. Size 12×6½×8½in. deep. **CAN BE BUILT FOR** Carr. and packing 2/6. **£7/19/6**

PARCEL No. 2
Contains everything to build a T.R.F. 3-valve set for 200/250 A.C. mains, medium and long waves. Uses 6K7G, 6J7, 6V6 and metal rectifiers. Neat plastic cabinet, walnut or ivory flash, or wood cabinet. Size 12×6½×5½in. deep.
CAN BE BUILT FOR Carriage and packing 2/6. **£5/10/0**
INSTRUCTION BOOK for either above sets 1/- post free.
CABINETS ONLY. plastic or wood, **17/6**
Post 2/6
All components available separately.

MAKERS' SURPLUS TV COMPONENT BARGAINS

WIDE ANGLE 38 mm.

Line E.H.T. trans., ferrox-cube core, 9-16kV.	25/-
Scanning Coils, low imp. line and frame	25/-
Ferrox-cube cored Scanning Coils and Line Output Trans., 10-15 kV., EY51 winding. Line Trans. Complete with circuit diagram, the pair	50/-
Frame Output Transformer	6/6
Scanning Coils, low imp. line and frame	17/6
Frame or line blocking osc. transformer	4/6
Focus Magnets Ferrox-dure	19/6
P.M. Focus Magnets. Iron Cored	19/6
Duomag Focalisers	22/6
300 m/a. Smoothing Chokes	15/-
Electromagnetic focus coil with combined scan coils	25/-

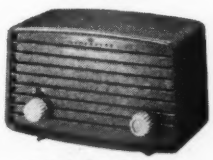
STANDARD 36 mm.

Line Output Transformers 6.9 kV. E.H.T. and 6.3 v. winding. Ferrox-cube	19/6
Scanning coils. Low imp. line and frame	12/6
Ditto by Igranic	14/6
Frame or line blocking oscillator transformer	4/6
Frame output transformer	7/6
Focus Magnets Without Vernier	12/6
With Vernier	17/6
Focus Coils, Electromagnetic	12/6
200 m/a. Smoothing Chokes	10/6

New AVO MULTIMINOR. 19 ranges A.C. and D.C. 10,000 ohms per volt. D.C. 1,000 ohms per volt A.C. Pocket size: 5⅜ × 3⅜ × 1¾in. Complete **£9/10/-**. Post 3/6.

***H.P. TERMS & CREDIT SALES available on certain goods**

LASKY'S NEW MIDGET T.R.F. CONSTRUCTOR PARCEL



CAN BE BUILT FOR ONLY 99/6
Post & Pkg. 5/-
Handsome contemporary design case, overall size 8½in. wide, 4½in. deep, 5in. high. 2 latest double-purpose valves EBF9 and ECL80, contact cooled rectifier. For A.C. mains 200-250 v. Med. and long wave, 5in. P.M. speaker. Plastic cabinet in cream, pastel green, pink, blue. FULL DATA, instructions, circuit diagram and shopping list, 1/6 post free.
All components available separately.
CABINET only, as illus., 12/6 plus 4/6 post and pkg.

BAND III CONVERTERS TURRET TUNERS AERIALS, Co-Ax. CABLE
Very large stocks. We have what you require.

CO-AX. CABLE
80 ohms semi-airspaced, finest quality, stranded. Per yard, **9d.** Dozen yards..... **7/6**
Post extra.
Any length supplied.

17in. C.R. TUBES
Rectangular, aluminised or ion trap 0.3 heater. Brand new and unused. **£12/19/6**
Carr. and Insur. 22/6.

BARGAIN OFFER!

POCKET VOLT TEST METERS
Two ranges, D.C. 0-250 v. and 0-25 v. Complete with leads in leather case.
LASKY'S PRICE 12/6
Post free. Send now to avoid disappointment.

CHASSIS
We have the largest stocks of chassis, A.M. and AM/FM.
A.M. chassis, l, m, s, from **7 Gns.**
AM/FM chassis .....from **14 Gns.**

FERRITE RODS
Large selection of Ferrite Rods, all lengths, in stock. Price, per rod, **2/6** to **3/6**.

MAINS TRANSFORMERS
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
MBA/3. 350-0-350 v. 80 mA. 6.3 v. 4 a. 5 v. 2 a. Both filaments tapped at 4 volts. **19/6**
MBA/7. 250-0-250 v. 80 mA. 6.3 v. 3 a., 5 v. 2 a. Both filaments tapped at 4 volts. **19/6**
AT/3. Auto trans. 0-10-120, 200-230-240 v. 100 watts **19/6**
M.T./341. Tapped input 250-0-250, 120 mA., 6.3 v. 5 amps., fully shrouded.... **27/6**

FILAMENT TRANSFORMERS
All 200-250 v. 50 c.p.s. primary, finest quality, fully guaranteed.
6.3 v. 1.5 amp. **5/11**
6.3 v. 3 amp. **9/6**
0-30 v. 2 amp. tapped voltages, **19/6**

GERMANIUM CRYSTAL DIODES
GEX.00 **1/6**. GEX.34 **3/6**. WG5 **3/6**. GEX. 54 and OA74 **5/-**. GD3 **3/6**. GD4 **3/6**. CG12E **5/-**.

SPECIAL RECTIFIER OFFERS

RM.0, 125 v. 30 m/a...	4/11
RM.1, 125 v. 60 m/a...	5/11
RM.2, 125 v. 100 m/a...	6/6
RM.3, 125 v. 120 m/a...	7/6
RM.4, 250 v. 125 m/a...	16/-
RM.5, 250 v. 150 m/a...	21/-

Post extra.
All makes and types in stock. Send to us for your requirements.

20,000 VALVES IN STOCK
Here are a few examples of brand new surplus and imported valves:

EB91	7/6	EV41	10/6	EL84	11/6
EB41	7/6	EF80	10/6	ECF80	15/-
EABC80	10/-	EF85	10/6	EZ40	8/6
EAF42	10/-	EF86	14/-	EZ80	8/6
EBC41	10/-	EF89	10/-	PCL82	12/6
ECC85	10/-	6K8	10/6	PCC84	12/6
ECC84	15/-	6V6	8/6	PL82	10/6
ECC83	9/-	6K7	5/6	PL83	11/6
ECC82	9/-	6Q7	10/6	PY80	10/6
ECC81	9/-	6B7	6/6	PY81	10/6
12AT7	8/6	5Z4	9/6	PY82	10/6
12AU7	8/6	DAF96	10/-	PY83	10/6
12AX7	9/6	DL96	10/-	6AT6	7/6
EB89	10/6	DK96	10/-	6AT7	7/6
EFC82	15/-	DF96	10/-	185	7/6
ECH42	11/6	DM70	9/-	384	9/-
ECH81	11/6	EY51	12/6	1T4	9/-
ECL80	10/6	EC84	11/6	1R5	7/6

Also full stocks of B.V.A. Valves and C.R. Tubes at the new lower list prices.
WRITE FOR COMPLETE LIST

LASKY'S (HARROW ROAD) LTD.

LASKY'S RADIO

42 TOTTENHAM COURT ROAD, W.1.
Nearest Station Goodge Street
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370 HARROW ROAD, PADDINGTON, W.9.
(Opposite Paddington Hospital)
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Open all day Saturday Early closing Thursday (both addresses)

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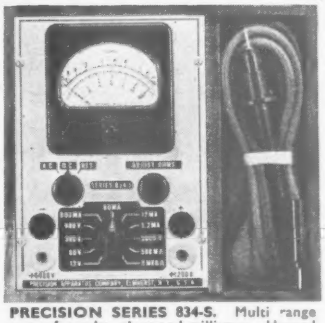
BARGAINS IN TEST EQUIPMENT

VALVE TESTER, TYPE 4. 200/230 v. A.C. input. Ex Govt., in good condition, with descriptive book containing circuit diagram of instrument and how to test valves from 1.4 v. to 40 v. With valve holders for Brit., 4, 5, 7 pin and Octal, U.S., 5 and 7 pin, 1/Octal, side contact, large Brit., 4 and 9 pin. Acorn and diode. Housed in substantial wooden case. **£7/19/6.** Carr. 10/-.

EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). The perfect meter for continuity and polarity testing. Complete with test leads and ready to use. Brand new. Only **£4/17/6.** P. & P. 3/-.



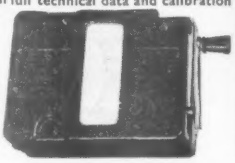
PRECISION SERIES 834-S. Multi range tester for volts, ohms and milliamps. Housed in wooden box with lid and carrying strap. Overall size 7½in. × 7in × 5in. Complete with test prods, batteries, etc. Ready to use. **£6/19/6.** Post 2/6.

METERS. 0–1 m/a 2in. circular F/M **17/6.** Ditto, 2½in., **25/-.** 0–50 microamps, D.C. m/c., projecting 2½in. round, **49/6.** 0–10 mA. A.C. m/c, rectifiers, F/M 3½in., round, **49/6.** 0–300 v. A.C. 2½in. F/M, **25/-.** 0–200 v. A.C. 3½in. F/M, **25/-.** 0–300 v. A.C. 3½in. F/M, **25/-** each.

S. METERS. 2in. circular calibrated in decibels 5 mA. FSD, **25/-** each. All brand new and boxed. P. & P. 1/- each.

TEST SET TS-26/TSM. This volt ohmmeter is the correct tester for EE8 telephones and all standard telephone equipment. Brand new and boxed, with full technical data and calibration charts. **£7/10/-.**

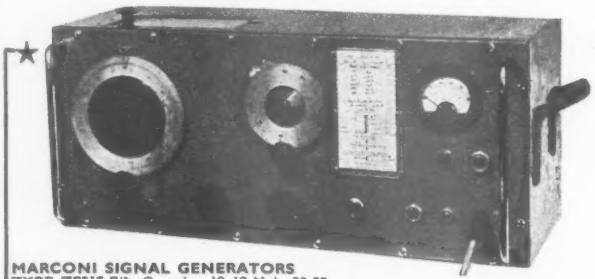
EVERSHED AND VIGNOLES WEE MEGGER 250 v. New and unused. Only **£10/10/-.** P. & P. 3/-.



COLLARO 4/564. Four-speed single record player with studio "T" p/u., crystal cartridge and styli. Automatic stop. OUR PRICE **£6/19/6.** Carr. 3/6.

AVO TEST BRIDGE. A.C. mains operated from 200-250v. Will test Resistance from 5 ohms to 50 megohms and Capacity from .00001 to 50 mfds. A most useful instrument for everyday uses. Our price ONLY **£7/19/6.** P. & P. 3/6.

RECORD MEGGERS. 500 v. insulation tester, 0-50 megohms. In leather case, good condition. **£9/10/-.**



MARCONI SIGNAL GENERATORS TYPE TF517-F/I. Covering 10–18 Mc/s, 33-58 Mc/s, 150–300 Mc/s. (A number available covering 18–33 Mc/s instead of 10–18 Mc/s band.) Used but in very good condition. Complete with full technical data and instructions. Limited quantity. Unrepeatable at only **£12/10/-,** carr. 20/-.

6 V. 125 A.H. STORAGE BATTERY in wooden carrying case. New and unused. Size 15½ × 11 × 7½in. **69/6.** Carr. 10/-. DITTO. 40 A.H. Size 10½ × 9½ × 5in. **21/-.** Carr. 5/-.

ACCUMULATORS. Bakelite cased 2 v. 100 ampere, 75 actual. Ex Govt. New and unused. Complete with carrying handle. Size 6½in. × 6½in. × 3½in. **15/-** each. Carr. 3/6. 3 sent for **50/-** or 6 for **£5** carr. paid. Ditto, 14 A.H. less handle **5/6.**

OLDHAM MINERS' LANTERN (all steel). 9½in. tall, 3½in. dia. Complete with bulb and rechargeable accumulator. Ideal inspection lamp for garages, outhouses, etc. **19/11.** Post 2/6.

TRANSFORMERS

RCA PLATE TRANSFORMERS. 190 to 250 v. primary. 50-60 cycles. Secondary 1,500-0-1,500 or 2,000-0-2000, at 1.75 k.v.a. Brand new and boxed. **£12/10/-.** Carr. 10/-.

L.T. TRANSFORMERS. Pri. 200-250 v. 50 cycles A.C., Sec 17.5 v. at 35 amps. **£4/15/-,** carr. 10/-.

TRANSFORMER (FERRANTI). Potted for 0-250 v. 50 cycles tapped primary, sec. 1,250 v., 15 mA. Ideal for oscilloscopes, etc. Size 3½ × 3½ × 4½in. ONLY **35/-.** P. & P. 2/6.

E.H.T. TRANSFORMERS. 3,850 v. at 50 mA. with two additional 4 v. L.T. windings, for 230 v. 50 cycles primary. New and boxed. **£3/15/-.** Carr. 5/-.

TRANSFORMERS. 110–230 v. Pri. Sec. 26 v. tapped to 41 v. at 14 amps. New and boxed. **£3/10/-.** Carr. 5/-.

CAR RADIO VIB. TRANSFORMERS. 6 v. Input 280 v. at 80 mA. H.T. (ex Philco). New in perfect condition. **12/6.** P. & P. 2/-. Ditto 12 v., same price.

E.H.T. TRANSFORMER. 20 kV. at 140 m/a 230 v. 50 cycles primary New and unused. Ex Govt. Built to the highest specification. **£22.** Carr. 30/-.

TRANSFORMER. 1,800–0–1,800 at 1 kVA, 230 v 50 cycles primary. Fully tropicalised. New and boxed. **£8/15/-.** Carr. 10/-.

RE-ENTRANT LOUD-HAILERS Heavy duty 20 watts all-metal. 15 ohms. Diameter 18in. length 12in., (approx). By Parmeko, **£6/10-,** carr. 10/-.

18/24 v. 10 AMP. BATTERY CHARGERS for 200–250 v. 50 cycles input, metered, switched and fused. As new. **£12/10/-.** Carr. 20/-.

A.C.-D.C. RECTIFIER POWER SUPPLY UNIT. 230 v. A.C. 50 cycles input. 100 v. D.C. output max 10 amps. **£15** Carr. 20/- Ditto at 2½ amp. **£4/10/-.** Carr. 7/6.

SELENIUM METAL RECTIFIERS. F/B.

6 or 12 v. 1 amp.....	7/6	24 v. 1 amp.	13/6
12 v. 2 amp.....	10/-	24 v. 2 amp.....	20/-
12 v. 2½ amp.....	15/-	24 v. 2½ amp.....	25/-
12 v. 4 amp.....	16/6	24 v. 4 amp.....	30/-
12 v. 6 amp.....	23/6	24 v. 6 amp.....	35/-
12 v. 10 amp.....	40/-	24 v. 10 amp.....	80/-

SPEEDY DELIVERY OF ALL TYPES OF RECTIFIERS HALF WAVE F/B, SINGLE PHASE OR THREE PHASE TO ORDER. FULLY GUARANTEED.

C.M.G. 25 PHOTO CELLS (OSRAM). Brand new **15/-.** P.P. 1/-.

B.C.929A CRT INDICATOR UNIT. Containing 1–3PB1 3in. C.R.T., 3–6SN7s, 2–6H6s, 1–6G6, 1–6X5, 1 2X2; 8 valves in all. Ideal for 'scope conversion. New, in original sealed cartons. **70/-.** Carr. 5/-.

12 v. D.C. ROTARY CONVERTERS. To 230 v A.C. 50 cycles, 100 watts. Fully tested. **£6/9/6.** Carr 7/6. Ditto 24 v. D.C. **£4/17/6.** Carr. 7/6.

MICROPHONE STANDS. 3 sections of 18½in. Extends to 56in. Stands on 3 legs which fold together. **21/-.** P. & P. 2/6.

20-WAY TELEPHONE PLUG AND INDICATOR BOARDS. Standard G.P.O. fitting. New and unused in sealed cartons. **15/- each either type.**

G.P.O. 19in. RACKS. Heavy channel 4ft. 10in. high. **59/6.** Carr. 10/-. Undrilled 14 S.W.G. steel panels for above with hinged cover, finished blue-grey. New and unused. **15/-.** P. & P. 5/-. Post free with rack.

CATHODE RAY TUBES. VCR139A 2½in. **30/-;** 3BP1, 3in., **30/-;** 5FP7, 5in., **35/-;** VCR97, 6in., **20/-.** All new and unused. P. & P. 3/- each.

TRANSMITTERS AND RECEIVERS

AIRCRAFT RADIO RECEIVERS BY RCA (Model No. CRV 46151). Freq. 195 kc/s to 9,050 kc/s. (33–1,500 metres) continuous. For 28 v. D.C. input with built-in dynamotor. This 6-valve receiver with 2 R.F. stages and 2 I.F. stages, B.F.O. and C.W. **£10,** or complete with A.C. mains power-unit for speaker or 'phones. Ready for use. **£15/10/-.** Carr. 10/-.

R109A RECEIVERS. Freq. range 2–12.0 megs. In good working order. **£4/7/6.** Carr. 10/-. A.C. mains 200–250 v., power packs available. **£4.** Carr. 5/6.

TRANSMITTER-RECEIVER No. 19. Mk. II complete with 15 valves. Frequency range A set 2–8 meg., B set 230–240 Mc/s., in good condition. **£2/19/6.** Carr. 10/6. 12 V. ROTARY POWER UNIT for above. **£1.** Carr. 5/-. All leads, headsets, variometers, etc., available.

BENDIX RECEIVER M.N.26. Covers 150–1,500 kc/s. on 3 bands. This 11-valve superhet is complete with dynamotor and in perfect condition. **65/-.** Carr. 8/6.

COMMAND TRANSMITTERS. 4 to 5.3 megs. Complete with valves and crystal. New and boxed. **35/-.** Post 3/-.

COMMAND RECEIVERS. B.C. 454, 3–6 Mc/s. Brand new. **39/6.** 455, 6–9 Mc/s. **39/6.** P. & P. 3/- each.

RECEIVER R1392 P 104. 15-valve superhet set, 95–150 Mc/s. (2 to 3 metres), slow-motion tuning, normally crystal controlled or tunable over 95-150 Mc/s. Receiver front panels made to fit 19in. Rack Mounting. External power supply required, good order. **£5/19/6.** Carr. 15/-.

Hours of Business:
9-6 Weekdays
9-1 Saturday

GEE Bros. RADIO Ltd.

ADJOINING
LEICESTER SQ.
TUBE STATION

15, LITTLE NEWPORT STREET, LONDON, W.C.2. Telephone: GERrard 6794/1453

SPECIAL TERMS FOR QUANTITIES—EXPORT ORDERS PROMPTLY EXECUTED

AND NOW THERE ARE TWO

Stern's "fidelity" TAPE RECORDERS

"JUNIOR"

PRICE . . . Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

£49.10.0 (OR £3 EXTRA WITH REV. COUNTER)

CREDIT SALE: Deposit £12/8/- and 9 monthly payments of £4/10/8.
HIRE PURCHASE: Deposit £24/15/- and 12 monthly payments of £2/5/11.

IT INCORPORATES: The NEW TRUVOX Mk. IV TAPE DECK together with the "fidelity" MODEL HF/TR2 TAPE AMPLIFIER (both fully described on this page), and a Rola 10in. x 6in. P.M. speaker.

PRICE . . . Including CRYSTAL MIKE and 1,200ft. reel of PLASTIC TAPE.

39GNS.

CREDIT SALE: Deposit £10/5/- and 9 monthly payments of £3/15/2.
HIRE PURCHASE: Deposit £20/10/- and 12 monthly payments of £1/18/-.

(Plus £1/10/- carriage and insurance, of which £1 is refunded on return of Packing Case.)

IT INCORPORATES: THE TRUVOX MK. III TAPE DECK together with correctly matched HF/TR1A TAPE AMPLIFIER and a 7in. x 4in. Speaker.

BEFORE CHOOSING YOUR TAPE RECORDER YOU SHOULD HEAR THESE MODELS—TRULY "Hi-Fi" RECORDINGS ARE OBTAINABLE and they are comparable to much higher-priced Recorders.

Alternatively send S.A.E. for ILLUSTRATED LEAFLET

THE NEW TRUVOX Mk. IV TAPE DECK

ONE OF THE BEST DECKS ON THE MARKET

PRICE £27.6.0 (Plus 10/- carr. and ins.)

CREDIT TERMS: Deposit £6/17/- and 9 monthly payments of £2/10/-.

H.P. TERMS: Deposit £13/13/- and 12 monthly payments of £1/5/4.

SPECIFICATION:— ● 3 B.T.H. shaded pole motors with silent friction drive eliminating wow and flutter. ● Push-button controls, electrically and mechanically interlocked (patented). ● Patented electric-type push-button controlled brake. ● Inching to assist editing; tape loading on the drop-in principle; accommodation for reels of 7in. diameter. ● Tracking sense. To British and American standards. ● Playing times: Up to 3 hours with L.P. Tape or 2 hours with Standard Tapes. ● Two tracks side by side, with safety gap. ● Playing time indication by precision revolution counter of large visual type indicator plate, according to choice. Positive Azimuth adjustment of Record/Player Head. ● High Impedance Heads. ● The metal work is Gold Hammered finish. ● Overall size 14½in. × 12½in., from top of face of panel, overall depth 8in.

The Mk. IV DECK CAN ALSO BE SUPPLIED INCORPORATING PRECISION REV. COUNTER for £30/9/-. **H.P. TERMS:** Deposit £15/4/6 and 12 months of £1/8/3.

CREDIT SALE: Deposit £7/12/3 and 9 months of £2/15/10.

A COMPLETE KIT OF PARTS TO BUILD

The "fidelity" TAPE AMPLIFIER Model HF/TR2 including POWER SUPPLY UNIT

FOR ONLY **£12.0.0** (Plus 5/- carr. and ins.)

This amplifier has been expressly designed to meet the requirements of the enthusiasts for High Fidelity reproduction. It is based on the very successful design, completed by the Mullard Technicians and only really high-grade components are incorporated; truly HIGH FIDELITY Recordings are obtainable whilst "Hi-Fi" reproduction is assured by use of a high-quality Output Transformer by Gilson. It incorporates a "magic eye" Recording Level indicator, a two-position equaliser for 3¾in. and 7½in. speeds, and an effective Tone Control arrangement. Monitoring and Extension Speaker Socket are incorporated and in addition a position is provided to enable it to be used as an independent Amplifier for Gramophone Records or Radio Tuning Unit. Overall size: 11in. × 6in. × 6in. high. Suitable for nearly all makes of Tape Decks. When ordering, please advise make of deck in use.

THE ASSEMBLY MANUAL PRACTICAL DIAGRAMS. etc., are available for 2/9 or send S.A.E. for brief details.

WE ALSO SUPPLY THE HF/TR2 ASSEMBLED AND READY FOR USE FOR £16.0.0 (Plus 6/- carr. and ins.). **H.P. TERMS:** Deposit £8 and 9 monthly payments of £1. **CREDIT TERMS:** Deposit £4 and 9 monthly payments of £1/9/4.

HOME CONSTRUCTORS

BUILD YOUR OWN RECORDER . . . WE OFFER

(a) The model **HF/TR2 AMPLIFIER and POWER UNIT**, both fully assembled, together with the **TRUVOX MK. IV TAPE DECK** for £38 10 0
ALTERNATIVELY as above but the **HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS** £35 0 0

(b) The model **HF/TR2 AMPLIFIER and POWER UNIT** both fully assembled, together with the TRUVOX TAPE DECK incorporating PRECISION REV. COUNTER £41 10 0
ALTERNATIVELY as above but the **HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS** £38 0 0

(c) The model **HF/TR2 AMPLIFIER and POWER UNIT, both fully assembled**, together with the COLLARO TRANSCRIPTOR £35 0 0
ALTERNATIVELY as above but the HF/TR2 Amplifier and P/Unit as a COMPLETE KIT OF PARTS £31 10 0
plus 12/6 carriage and insurance.

TO COMPLETE THE RECORDER . . . WE OFFER

The Portable Carrying Case . . . Acos Crystal Mike . . . Rola 10in. × 6in. P.M. SPEAKER . . . 1,200ft. Plastic Tape.

ALL FOR **£8.10.0** (plus 7/6 Carr. & Ins.)

STERN'S TAPE PRE-AMPLIFIER and ERASE UNIT

Provides the 'Link' between the HIGH-QUALITY AMPLIFIER & TAPE DECK

MODEL HF/TR1P . . . A completely assembled Pre-Amplifier with own Power Supply. Can be supplied correctly matched for use with Truvox or Collaro Decks, and incorporates Recording Level Indicator and Monitoring facilities.
Please send S.A.E. with any inquiry.

PRICE **£11.10.0** (plus 5/- carr. and insurance)

WE MAKE SPECIALLY REDUCED PRICES FOR COMBINED ORDERS

ADD TAPE TO YOUR EXISTING AMPLIFIER . . . WE OFFER YOU

(a) The Model **HF/TR1P TAPE PRE-AMPLIFIER** together with the **TRUVOX MK. IV TAPE DECK** £35 0 0
(b) **ALTERNATIVELY** as in (a) above but Truvox Deck incorporating **PRECISION REV. COUNTER** £38 0 0
(c) The model **HF/TR1P TAPE PRE-AMPLIFIER** together with the **COLLARO TRANSCRIPTOR** Tape Deck £31 10 0

PLEASE INCLUDE 12/6 to cover cost of carriage and insurance.

HIRE PURCHASE and **CREDIT SALE TERMS** are available on all equipment (excluding Kits of Parts). Send **S.A.E.** for details.
NOTE . . . The Collaro Transcriptor is in short supply and there may be a delay in delivery. We will however book an order.
The Deck switches of the Transcriptor have to be "wired-up." We will complete this wiring, for use with either the HF/TR2 or the HF/TR1P, for an extra charge of £1.

Open Monday to Friday 9 a.m.—6 p.m. Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

(DEPT 109/W)

109 & 115 FLEET ST., LONDON, E.C.4

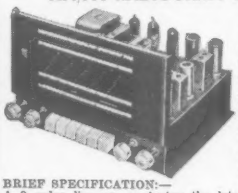
Telephone: **FLEet St. 5812/3/4**

MODERNISE YOUR OLD RADIOGRAM

IT'S MUCH BETTER

THE NEW ARMSTRONG P.B.409 AM/FM RADIOGRAM CHASSIS

PRICE

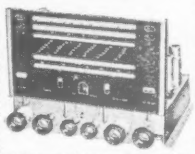


£29.8.0
(Plus 7/6 carr. and ins.).

TERMS: Credit Deposit £7/7/- and 9 monthly payments of £2/14/-. H.P. Dep. £14/14/- and 12 monthly payments of £1/7/3.

BRIEF SPECIFICATION:—
A 9 valve line up employing the latest MULLARD preferred-type valves. ● Provides complete coverage of the VHF/FM Transmissions, plus the SHORT, MEDIUM and LONG waves. ● Has Push-Pull output, with negative feedback, for 6 watts Peak output. ● Quick action "Piano Joy" Selectors and separate Bass and Treble Controls. ● Has "Magic Eye" Tuning Indicator. ● Dimensions 13in. × 9¾in × 8in. high. Dial size 11⅛in. × 5¼in.

THE ARMSTRONG MODEL A.F. 105 AM/FM RADIOGRAM CHASSIS
A Genuinely Hand Made Chassis



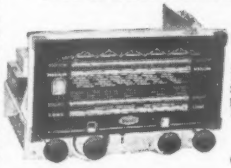
Developed to meet the needs of those who require really high quality radio and record reproduction but who, for reasons of expense or lack of room in existing or proposed cabinets, cannot consider the normal high-fidelity system. The A.F.105 is as good as, or better than, many of the high quality amplifiers, and Associated units. Independent and continuously variable Bass and Treble controls give a wide range of control. **SEND S.A.E. FOR DETAILS.**

PRICE **£37** (Plus 7/6 carr. and ins.).

CREDIT SALE TERMS: Deposit £9/5/- and 9 monthly payments of £3/7/10.
HIRE PURCHASE TERMS: Deposit £18/10/- and 12 monthly payments of £1/14/4.

IT'S MUCH CHEAPER

THE DULCI MODEL H.4



COMBINED AM/FM RADIOGRAM CHASSIS

A 4 Waveband Receiver designed for first-rate reproduction of Radio and Gram.

PRICE
£24.6.6
(Plus 7/6 carr. & ins.).

CREDIT TERMS: Deposit £6/2/- and 9 monthly payments of £2/4/7. **H.P. TERMS:** Deposit £12/3/3 and 12 monthly payments of £1/2/7.

BRIEF SPECIFICATION:—
- Covers Short, Medium, Long and F.M. Wavebands.
- Employs full A.V.C.
- The latest 7-valve line-up.
- For 3 or 15 ohm P.M. Speakers.
- "Magic Eye" Tuning Indicator.
- Excellent Tone range up to 4 watts output
- Internal aerial for local stations.
- Overall size 12in. × 8¼in. × 7¾in. high.

A good Quality Chassis and Well Recommended.

THE DULCI MODEL H.4T
Combined AM/FM Tuning Unit incorporating own Power Supply.

MODEL H.4T. This model is the "TUNER UNIT VERSION" of the H.4 Radiogram Chassis illustrated and described above. It has the same coverage of A.M. and F.M. Wavebands (4 altogether) and precisely the same in size and appearance, except that it has three Controls only, being: TUNING, WAVECHANGE and Volume On/Off, mounted centrally on the chassis. A self-contained Tuner incorporating own Power Supply.

PRICE
(plus 7/6 carr. & ins.) **£20.17.0**

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/19/4. **H.P. TERMS:** Deposit £10/8/6 and 12 monthly payments of 19/4.

HOME CONSTRUCTORS !!
BUILD YOUR OWN "Hi-Fi" LOUDSPEAKER SYSTEM

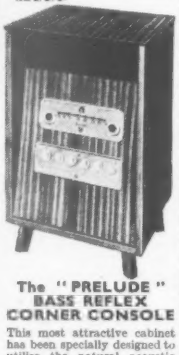
WITH W-B's WELL-KNOWN RANGE OF READY-TO-ASSEMBLE CABINETS. ALL ARE BEAUTIFULLY MADE AND FINISHED AND VERY EASILY ASSEMBLED. ONLY A SCREWDRIVER IS REQUIRED, THEY ARE PACKED FLAT IN CARTONS AND COMPLETE WITH SCREWS.
WE SHOW A FEW HERE BUT OTHERS ARE AVAILABLE. SEND S.A.E. FOR LEAFLET.

CALL IN AND LISTEN TO THEM.

THE JUNIOR BASS REFLEX CORNER CONSOLE

A new contemporary-style cabinet, specially designed to give maximum reproduction quality from Stentorian 8in. or 10in. units with provision for Tweeter Unit, if required. Measures 33in. × 22½in. × 18½in. Price £9/9/- or with the 8in. Stentorian Speaker £13/12/6 or with 10in. Stentorian Speaker, £14/8/6.

The "PRELUDE" Hi-Fi CONSOLE CABINET



Takes any make of tape-deck or record player amplifier, pre-amplifier control unit, and radio tuner. Size 33in. × 19in. × 19½in. Height above baseboard is 6¾in. Price £13/13/-.

The "PRELUDE" BASS REFLEX CORNER CONSOLE

This most attractive cabinet has been specially designed to utilise the natural acoustic properties of the walls, and is also obviously suitable for use where space-saving is a consideration. It's sturdily constructed to take every advantage of Stentorian 8in. or 10in. units, with provision for Tweeter Unit. Size 33in. × 21in. × 17in. Price £12/10/- or with the 8in. Stentorian Speaker £14/13/6 or with the 10in. Stentorian £15/9/6.

The "PRELUDE" Hi-Fi TABLE CABINET

Designed to take any make of Tape Deck or Single Record Player (not Auto-changers) Amplifier Pre-amplifier Control Unit, and Radio Tuner. Price £9/19/6. Size 19½in. × 19in. × 19½in.

HIRE PURCHASE and CREDIT SALES TERMS ARE AVAILABLE . . . SEND S.A.E. for details.
WE ALSO HAVE THE GOODMANS SHERWOOD ENCLOSURE IN STOCK.

THE DULCI MODEL H3.
COMBINED AM/FM RADIOGRAM CHASSIS

This model is very similar to the model H.4 described above but covers 3 WAVEBANDS instead of 4 (omitting the Short Band) and is for 3 ohm Speakers only. Overall size is as for the H.4.

PRICE **£20.17.0** (Plus 7/6 carr. and ins.).

CREDIT TERMS: Deposit £5/4/3 and 9 monthly payments of £1/18/4. **H.P. TERMS:** Deposit £10/8/6 and 12 monthly payments of 19/4.

Stern's "fidelity" F.M. TUNING UNIT

A 5-Valve Tuner incorporating the latest Mullard Permeability Tuned Unit. Price assembled less Power Supply:

£14.10.0
(Plus 7/6 carr. and ins.).

TERMS: (a) H.P. Deposit £7/5/- and 9 monthly payments of 18/4.
(b) Credit Deposit £3/12/6 and 9 monthly payments of £1/6/7. Provides "Hi-Fi" reproduction with any make of Amplifier and many Radio Receivers. It incorporates:
● The latest Valve line-up—ECC85, 2 type EF85, EF91 and EM80. ● A "Magic Eye" Indicator. ● Power consumption is 1.7 amps. at 6.3 volts and 25 m/a at 250 volts.

STERN'S "fidelity" COMBINED A.M. and F.M. TUNING UNIT

This is IDENTICAL to the Stern's F.M. Tuner illustrated above, but in addition incorporates the MEDIUM WAVEBAND and thereby also provides a selection of foreign stations. PRICE **£18.18.0** (Plus 7/6 carr. and ins.).

TERMS:—(a) H.P. Deposit £9/9/- and 10 monthly payments of £1/1/-; (b) Credit Deposit £4/15/- and 9 monthly payments of £1/14/7. Send S.A.E. if further data required.

HOME CONSTRUCTORS . . . You can build
(a) The "fidelity" F.M. TUNING UNIT FOR **£10.0.0**
(b) The "fidelity" AM/FM TUNING UNIT for **£13.10.0**

The COMPLETE ASSEMBLY DIAGRAMS and INSTRUCTIONS CAN BE OBTAINED FOR 1/6 each.

!! SPECIAL CASH OFFERS !!

The Latest Collaro 4 Speed Single Record Player
Incorporating the very popular STUDIO "0" CRYSTAL PICK-UP
For only **£6.19.6**
(Plus 5/- carr. and ins.).
Incorporates Auto-Stop and Plays 78 r.p.m. and all types of L.P. Records.

The Collaro "Junior" Rim Drive 4 Speed Record Player
Offered complete with Collaro Crystal Pick-up For £4/10/0.
(Plus 4/- carr. and ins.)
We also offer . . . Gram Motor and Turntable at £3/2/6. Crystal Pick-up only. £1/12/6.
(Carr. and Ins. 2/6 extra).

"FRUSTRATED EXPORT ORDER"

The Cossor Model 527/X4 Valve "All-dry" Battery Portable.
Offered For **£6.15.0**
Plus 5/- carr. & ins

Consists of a 4 valve Superhet Receiver covering Medium Waveband 197-575 metres, and two Short Wavebands 13.5 to 136 metres. The new low consumption valves are incorporated and the whole is accommodated in an attractive robustly made case. Battery required is 90 volts and 1.4 volts (price 19/6) and is external to case.

RECORD PLAYERS
THE VERY LATEST MODELS ARE IN STOCK
MANY AT REDUCED PRICES ! ! ! !
TRANSCRIPTION UNITS—AUTOCHANGERS SINGLE RECORD PLAYERS
Send S.A.E. for ILLUSTRATED STOCK LIST

CASH ONLY OFFER ! ! !

This latest Brand New B.S.R. MONARCH 4-SPEED AUTOCHANGER
£7.19.6 (Plus 5/- carr. and ins.)
● Minimum baseboard size required 14in. × 12¼in. with height above 5¼in. & height below baseboard 2¼in.

WE ALSO HAVE A FEW ONLY

COLLARO 4-Speed "Mixer" Autochangers. The Units are BRAND NEW and incorporate the STUDIO "0" Pick-up. PRICE **£8.15.0** (Plus 5/- carr. and ins.)

Open Monday to Friday 9 a.m.—6 p.m.
Saturday 9 a.m.—1 p.m.

STERN RADIO LTD.

AMPLIFIERS
PRE-AMPLIFIERS

HIGH FIDELITY FOR THE HOME CONSTRUCTOR

TUNING UNITS
RADIO RECEIVERS

—COMPLETE KITS OF PARTS FOR THE "Hi-Fi" ENTHUSIAST—

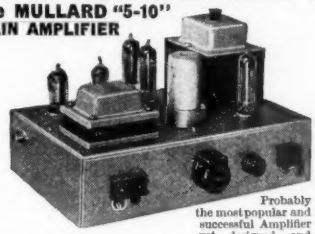
QUALITY OF THIS NATURE HAS NEVER BEFORE BEEN OFFERED AT SUCH LOW COST

STERN'S REMOTE CONTROL UNIT

Designed in particular for use with the MULLARD 5-10 Main Amplifier.

Ideally suited for simple domestic installation as an alternative to the more elaborate Pre-amplifier (shown and described opposite). Tone Control facilities are really excellent and in conjunction with the "5-10" Main Amplifier reproduction is of very high quality. Perfectly suitable for use with all the popular Record Players (B.S.R., Collaro, Garrard) and the modern Radio Tuner Units. Front Panel contains: (a) Coloured Indicator; (b) Separate BASS and TREBLE CONTROLS; (c) 3 position Selector Switch; (d) Volume Control. Inputs on back for Radio and Gram and Gram equalising is incorporated.
FULL DATA is contained in the 5-10 MAIN AMPLIFIER MANUAL at 1/6.

The MULLARD "5-10" MAIN AMPLIFIER



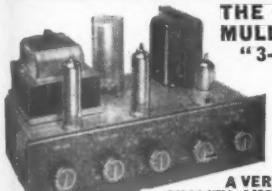
Probably the most popular and successful Amplifier yet designed and certainly needs no recommendation from us. Our kit is complete to MULLARD8 specification including the latest PARMEKO ULTRA LINEAR OUTPUT TRANSFORMER and the recommended Mullard Valve line-up. All specified Components are supplied and Power Supply is available to drive a Radio Tuner Unit.
PRICE OF COMPLETE KIT OF PARTS (Plus 5/- carr and ins.) **£9.10.0**
or alternatively we supply—
FULLY ASSEMBLED AND TESTED for (Plus 5/- carr. & ins.) **£11.10.0**
WE ALSO OFFER THE "5-10" INCORPORATING THE LATEST PARTRIDGE ULTRA LINEAR OUTPUT TRANSFORMER FOR AN EXTRA £1/6/-.
The ASSEMBLY MANUAL containing FULL SPECIFICATION is available for 1/6. It also includes full data on the REMOTE CONTROL UNIT.

STERN'S "fidelity" PRE-AMPLIFIER-TONE CONTROL UNIT

"A design for the Music Lover"

This unit can be used with any Main Amplifier. Briefly it has inputs for all types of MICROPHONES, HIGH and LOW GAIN PICK-UPS and a RADIO TUNING UNIT. It incorporates (a) GRAM EQUALISING CONTROL. (b) STEEPCUT FILTER. (c) Continuously variable BASS and TREBLE CONTROLS. A variable OUTPUT CONTROL which enables its use with any type of Amplifier, and Jack Sockets are incorporated for TAPE RECORD and TAPE PLAYBACK.
Used with the "5-10" the reproduction is comparable to that normally associated only with the very expensive commercially made High Fidelity Amplifiers. **£6.16.0**
PRICE OF COMPLETE KIT OF PARTS.
WE ALSO OFFER IT ASSEMBLED READY FOR USE **£8/10/-** (plus 5/- carr. & ins.).
The ASSEMBLY MANUAL contains full specification and is available for 1/6.

THE NEW MULLARD "3-3"



A VERY HIGH QUALITY AMPLIFIER PROVIDING EXCELLENT REPRODUCTION AND HAVING AN ATTRACTIVE ENGRAVED PERSPEX FRONT PANEL.

Price: FOR COMPLETE KIT OF PARTS (plus 6/6d. carriage and insurance). **£7.10.0**
Alternatively supplied ASSEMBLED and FULLY TESTED (plus 6/6d. carriage and insurance.) **£8.19.6**
The complete specification is available for 1/6d.
Developed from the very popular 3-valve 3-watt Amplifier designed in the Mullard Laboratories. Our kit is complete to the Mullard specification, including supply of specified components, valves and a PARMEKO OUTPUT TRANSFORMER. We also include switched inputs for 78 and L.P. records plus a Radio position. Extra power to drive a Radio Tuning Unit is also available.
THE IDEAL AMPLIFIER FOR A SMALL HIGH QUALITY INSTALLATION.

SPECIAL PRICE REDUCTIONS—WE OFFER

(a) The **COMPLETE KIT OF PARTS** to build both the **MULLARD 5-10** and the **REMOTE CONTROL UNIT** for **£11.11.0**
(b) The **COMPLETE KIT OF PARTS** to build both the **MULLARD 5-10** and the "fidelity" **PRE-AMPLIFIER-TONE CONTROL UNIT** for **£15.15.0**
ALTERNATIVELY WE WILL SUPPLY ASSEMBLED and FULLY TESTED, as follows:—
(a) The **MULLARD 5-10** and the **REMOTE CONTROL UNIT** for **£14.0.0**
CREDIT SALE TERMS: £3/10/- Deposit and 9 monthly payments of £1/5/8. H.P. TERMS: £7 Deposit and 9 monthly payments of 17/9.
(b) The **MULLARD 5-10** and the "fidelity" **PRE-AMPLIFIER-TONE CONTROL UNIT** for **£18.18.0**
CREDIT SALE TERMS: £4/15/- Deposit and 9 monthly payments of £1/14/7. H.P. TERMS: £9/9/- Deposit and 12 monthly payments of 17/6.
THE ABOVE PRICES ARE SUBJECT TO £1/6/- EXTRA IF PARTRIDGE TRANSFORMER IS PREFERRED.
WHEN ORDERING PLEASE INCLUDE 7/6 to cover cost of Carriage and Insurance

A FEW ONLY!!! CASH OFFER

10-WATT POWER AMPLIFIER WITH STERN'S REMOTE CONTROL UNIT

A small "Surplus" purchase enables us to offer them for only **£10.0.0** (plus 6/6 carr. & ins.)

COMPLETE, TESTED and READY FOR USE.

A 5-Valve Amplifier having matched pair 6F6's in Push-Pull. Incorporates PARMEKO Mains Transformer. Choke and Output Transformer and provides really first class production. Has Power Supply available to drive Radio Tuning Unit.

A COMPLETE KIT OF PARTS, STERN'S 8-10 WATT AMPLIFIER

Has power supply available for Radio Tuning Unit.
Price of COMPLETE KIT OF PARTS (plus 5/- carr. & ins.) **£7.10.0**
WE ALSO OFFER IT ASSEMBLED and READY FOR USE for (plus 5/- carr. & ins.) **£9.10.0**
This amplifier has proved one of the most popular models yet offered to the HOME CONSTRUCTOR. It provides really excellent reproduction up to 8 watts, employing 6V6's in push-pull and incorporating negative feedback. Provides for the use of both 3 and 15 ohm Speakers. The complete SPECIFICATIONS and BUILDING INSTRUCTIONS are available for 1/6.

THE FOLLOWING HIGH FIDELITY AMPLIFIERS ARE IN STOCK

STERN'S COMPACT "5-2." A 2-stage high sensitivity Amplifier having separate BASS AND TREBLE Controls and GRAM EQUALISING. Developed for high quality reproduction, includes separate Power Supply Unit with spare power available to drive Radio Tuner. **£8.16.0**
THE DULCI MODEL D.P.A.10. A 10 watt "Ultra Linear" High Fidelity Amplifier with separate PREAMP-TONE Control Unit **£19.19.0**
THE DULCI MODEL H1L. A self powered AM/FM Tuning Unit combined with a "Hi-Fi" Pre-Amplifier Tone Control Unit—all on one Chassis. **£29.3.10**
THE ARMSTRONG MODEL A.10 Mk. II. With associate PREAMP-TONE CONTROL UNIT, this model is perfectly consistent with Armstrong's very high reputation. **£32.0.0**
THE NEW LEAK "VARISLOPE" PRE-AMPLIFIER together with the TL/12 plus AMPLIFIER. **£34.13.0**
THE "VARISLOPE" is available separately for **£15.15.0**
THE ROGERS "JUNIOR." With associate PREAMP-TONE CONTROL UNIT. **£26.0.0**
THE RGA "ORTHOPHONIC" 12-20 watt high Fidelity Amplifier and associate PRE-AMPLIFIER TONE CONTROL UNIT **£41.0.0**
HIRE PURCHASE and CREDIT TERMS are available on all models.
Descriptive leaflets are available. Send S.A.E.
F.M. TUNING UNITS by MOST OF THE LEADING MANUFACTURERS.

STERN'S POWER SUPPLY UNIT

Fully smoothed with all output connections terminated to connecting Blocks, thereby enabling ease of connecting to a Radio Tuner Unit or Amplifier, etc. Overall size of Units is 9½in. × 3½in. × 4½in. high. **TWO MODELS ARE AVAILABLE,** Type "A" Unit provides 250-300 volts at up to 70 m/a. and 6.3 volts at 3½ amps.
PRICE **£2.17.6** (Plus 2/- carr. and ins.)
Type "B" Unit provides 250-300 volts at up to 100 m/a and 6.3 volts at 3½ amps.
PRICE **£3.3.0** (Plus 2/-carr. and ins.).

SPECIAL CASH ONLY OFFER!!

This very attractive **PORTABLE AMPLIFIER CASE** together with a good quality **GRAM AMPLIFIER** and a matched **P.M. SPEAKER.**
ALL FOR ONLY **£8.7.6**
(plus 7/6 carr. & ins.). The Amplifier consists of a 2 Stage design incorporating the 3 modern BVA valves and has separate BASS and TREBLE CONTROLS. The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Grey colour Rexine—WE ALSO SUPPLY SEPARATELY:—

(a) The 2-Stage (plus Rectifier) **AMPLIFIER** £4/2/6
(b) The **PORTABLE CARRYING CASE** £3/17/6
(c) 6½in. **P.M. SPEAKER** 16/9
Carriage and insurance 4/- extra.

We also have a smaller **PORTABLE CASE ideal for Record Players.** PRICE ONLY **£3/3/-** (plus 3/- carr. & ins.). Attractively finished in high-grade Rexine and robustly constructed with internal measurements at 13½ × 15½in. high. It will therefore accommodate all makes of Record Players including Autochangers. An uncut baseboard is also supplied.

DEPT. 109/W

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DULCI H.4 PUSH PULL AM/FM chassis £29/3/10 plus 5/- p. & p.
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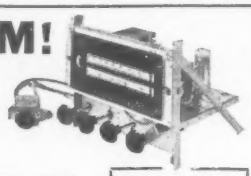
★STAR ITEM!

A *NEW* AM/FM CHASSIS

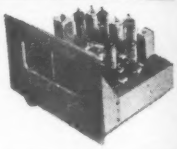
BY LEADING MANUFACTURER !



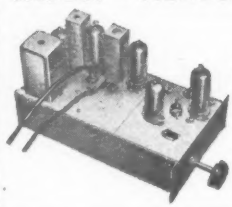
- ★ Seven valves: ECC85, ECH81, EF85, EABC80, EL84, EZ80, EM81.
- ★ Long, Medium, F.M. Bands and Gram.
- ★ Separate bass and treble controls.
- ★ Illuminated volume control on extended lead.
- ★ Mullard F.M. Tuner Section.
- ★ Attractive dial in Gold on Bronze background (Vertical or Horizontal to choice).
- ★ Fully Guaranteed.
- ★ £18/19/6 Plus 5/- P. & P.

This superb chassis is ideal as an up-to-the-minute replacement or as the basis of a new Radio-gram. Dimensions (overall) 12in. L. x 10in. W. x 10in. D. H.P. or Credit Sale Terms Available. Limited Stocks only.

ANNOUNCING OUR NEW F.M. TUNER KIT (printed circuit). This is our printed circuit version of the Osram 912 F.M. Tuner—using T.C.C. printed circuit and condensers, incorporating 5 valves and two germanium diodes. Attractive black and gold dial, with gold escutcheon plate. Dial aperture only 5 × 2in. Osram F.M. booklet plus our additional instructions and individually priced components list—2/6 post free or the Kit absolutely complete at £8/8/- plus 2/6 P. & P. Alignment service available if required We are demonstrating at both branches.



JASON "MERCURY" SWITCH TUNED FM FEEDER KIT

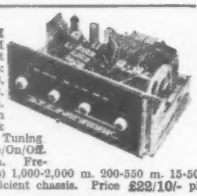


This excellent unit enables the selection of Home, Light or Third programme at the touch of a switch. Complete freedom from drift is ensured by the incorporation of Automatic Frequency Control. Valve line-up: 4-EF80 1-EFC80. Front end completely prefabricated. When used in conjunction with a suitable amplifier superb quality is obtainable. The highest standards of efficiency and reliability that are the well-known features of the Jason Standard and Fringe Model FM Tuners have been maintained. Instruction booklet and our itemised price list 2/- post free or the complete Kit £9/19/6, plus P. & P. 2/6.

THE RC 3/4 WATT AMPLIFIER KIT. Compare the advantages. Treble, bass AND middle controls. For crystal or magnetic pick-up. A.C. Mains 200/250 v. Valve line-up: 6V6GT, 6SG7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8in. × 4in. × 1¼in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at £4/5/- only, plus 2/6 packing and post or Instruction Book fully illustrated for 1/-. Post free. This amplifier can be supplied assembled, tested and ready for use at £5/5/-, plus P. & P. Hearing is believing.

DULCI F.3.AM. RADIOGRAM CHASSIS. We are very fortunate in being able to offer a further limited quantity of this very popular and efficient chassis at a greatly reduced price. Specification: Three wavebands, Long, Medium and Short. Valve line-up: X79, 6BA6 6AT6, EL84, 6X4 (or equiv.). Four controls; Tone. ON/OFF. Volume. Wavechange. Tuning. Output 4 watts matched to 3.5 ohms. Incorporates latest Ferrite Rod Aerial. Input sockets for crystal or magnetic pick-up. Provision for mains supply to gram motor. Overall dimensions 12in. L × 7in. D × 7¾in. H. Attractive dial with Red, Gold and Green lettering on Black background. Dial size 11¼in. × 4¼in. Price, whilst stocks last, only £10/5/-. plus 3/6 P. & P. Terms available.

RC4.FAM. AM/FM RADIOGRAM CHASSIS. A new style AM/FM Chassis employing a printed circuit FM Tuner section. Valve line-up: 8 valves ECC85, 6BA6, 12AH8, 6BA6, 6AL5, 6AT6, EL84, 5Y3. Most attractive dial 12 × 5¼in. fully illuminated with figures in green, red and white on black background. Four controls: Tuning Volume, Wavechange and Tone/On/Off. Dimensions (overall): 13 × 9 × 6in. Frequency coverage (four wavebands) 1,000-2,000 m. 200-550 m. 15-50 m., 88-100 mc/s. This is an excellent and very efficient chassis. Price £22/10/- plus 5/- P. & P.



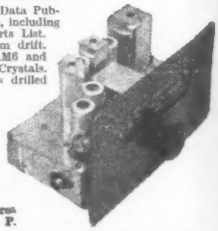
We proudly present this latest addition to our wide range of popular kits to build yourself. Enjoy your leisure free from anxiety. This highly efficient unit is simple to assemble, extremely sensitive and may be installed in a matter of minutes. Completely SAFE employing a double wound mains transformer. Attractively finished in Red and Grey (washable) "Lynide" with cream plastic escutcheon. Size only 7½in. × 3¾in. × 6¾in. Supplied in kit form complete with mike at ONLY 72/6 plus 2/6 P. & P. or assembled and tested 89/6 P. & P. 2/6. Suitable mike flex available at 3d. a yd. Instruction book and price list available separately 1/- post free. Note: For A.C. mains 200-250v. only.

JASON AM/FM KIT

This is a very high quality chassis for medium waves and F.M. incorporating 8 of the latest miniature valves, plus DM70 magic eye. Kits are available for chassis complete with output stage at £16/5/-. Also less output stage but with own built-in power pack at £13/19/6 only. These are high fidelity units and exceptional value at these prices which include all required components and full constructional details. Fully illustrated Data Booklet with full construction details, plus individually priced component list available per return of post 2/- post free. Both plus 3/6 P. & P.

JASON FM TUNER

Based on the booklet by Data Publication Ltd., 2/- post free, including our individually priced Parts List. Highly sensitive, free from drift. Incorporates 4 valves 6AM6 and 2 specially graded G.E.C. Crystals. The kit supplied includes drilled chassis with tuning condenser, scale calibrated in mc/s, and attractive bronze stove-enamelled front plate already mounted (illustrated). Front plate size 8in. × 5in. Chassis 7 in. × 4¼in. × 1¼in. Complete standard kit £6/15/- plus 2/6 P. & P. Fringe area kit £7/15/- plus P. & P.



FM POWER PACK KIT. We can now supply complete kit for power pack suitable for the above F.M. tuner or any other similar type. Price for the complete kit is 37/6 only or 52/6 for ready assembled unit. This pack is extremely small, incorporating valve rectifier type 6 × 4 and built on chassis size only 6in. × 4in. × 1¼in. Optional extra for power pack. Bulgin Octal Plug 2/3.

THE NEW R.C. TRANSISTOR/RECEIVER KIT

This receiver, covering medium waveband, which can be assembled in about 1 hour, will give amazing volume and tonal quality when used in conjunction with a good aerial and earth. Incorporating PNP Transistor and Germanium Diode. For headphone reception.
Included with the kit of parts is a handsome plastic case in black and white, measuring 4½ × 2¾ × 1¾in. This case accommodates the complete receiver, including battery **PRICE OF COMPLETE KIT 25/-, plus 1/3 P. & P.**
Lightweight high resistance headphones can be supplied separately at 15/- pair. If, however the kit is purchased complete with headphones this will be supplied at a **SPECIAL INCLUSIVE PRICE OF 37/6** plus 1/6 P. & P.
Optional extra. 100ft. coil single 7/36 coloured P.V.C. covered wire suitable for both aerial and earth, 2/6 only.

BARGAIN CORNER

TAYLOR "MONTROSE" POCKET TEST-METER. A most useful AC/DC multimeter with eight ranges covering: 3 amp. 300 mA. 30 mA. 6 v. 30 v. 150 v. 300 v. and Circuit Test. 3cale length app: 2in. Complete with test leads. Size: 3¾in. × 3in. × 1¼in. BRAND NEW. **FULLY GUARANTEED 63/-.** 'lus 1/-. P. & P.

WIRING WIRE. 5 coils 10 yards each in different colours contained in cellophane bag. 5/- bag plus 9d. postage.

DECCA Lightweight pick-up complete with Studio "O" turn-over crystal insert and sapphire styll. ONLY 47/6 plus 1/6 P. & P. BRAND NEW.

9in. × 5in. **ELLIPTICAL LOUDSPEAKERS** Few only. Brand new, 32/6 plus 1/6 P. & P.

DUAL CONCENTRIC CONE LOUDSPEAKER. 6½in. dia., 3-5 ohm speech coil. Excellent quality few only at 35/- each plus 1/- P. & P.

6½in. WAFER SPEAKERS. 3 ohm speech coil. Brand new. Few only. 22/6 plus 1/- P. & P.

NEW PLASTIC RECORDING TAPE. 1,200 ft. on plastic spool, 21/-, plus 1/6 p. & p. 3 spools for 63/-, post free.

BRAND NEW RECORDING TAPE. 1,200 ft. Kraft paper based recording tape. 10/- or 3 for 30/-.

Our advantageous H.P. and Credit Sale terms are available on any single item over £5. Your enquiries invited.

If not stated, please add postage on orders under £1. Cash with order or C.O.D. (charges extra).

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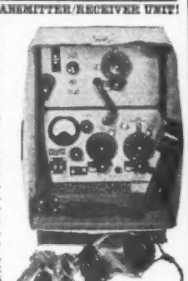
No. 38 TRANSMITTER/RECEIVER

(popular Walkie-Talkie). We have been most fortunate in obtaining a further supply of these complete stations comprising TX/RX unit, headphones, microphone, aerial, junction box, battery and full operating instructions. Range: approx. 5 miles. Frequency coverage 7.4-9 mc/s. ABSOLUTELY BRAND NEW. 65/-. Export enquiries invited.

No. 18 TRANSMITTER/RECEIVER UNIT!



We have just taken delivery of quantity of these fine units, brand new and complete. This is a very good portable, self-contained transmitter/receiver designed for short range telephony & C.W. Range: approx. 5 miles. Frequency coverage 6 mc/s-9 mc/s. All accessories supplied, i.e., Headphone, Mike, Morse Key, Aerial, comprehensive instruction book with circuit diagram. Valve line-up: 3 ARP12, 2 ARS, 1 ATF4. Weight approx. 22lb. Dimensions (overall): 8in. × 10in. × 17in. UNREPEATABLE at 99/6 plus 7/6 C. & P.

SPECIAL PURCHASE from MINISTRY BRAND NEW No. 17 Mk. II TRANSMITTER/RECEIVER

Built into strong wooden cabinet 15in. × 14in. × 9in. Complete with headphones and microphone. Range 5-8 miles with simple aerial. Frequency coverage 44-61 mc/s. (5-7 metres) Uses standard 120 v. H.T. and 2 volt L.T. batteries. Complete with full operating instructions. 59/6.

SURPLUS METER BARGAINS

We have large stocks of meters from 50 microamp to 300 v. and will be pleased to forward a complete list upon receipt of 3d. stamp.
METER RECTIFIERS. 1 ma. and 5 ma, each at 6/6. Brand new.

THE "NEW LOOK" RAMBLER

Our most popular All-Dry Portable Superhet Kit is now being supplied with a new cabinet of even more attractive appearance. The new cabinet is covered with "LIONIDE" which is washable and unscratchable. Colour: two-tone GREY/RED. The standard cream plastic top panel with dial engraved in red completes the overall "air of quality." This receiver really has everything. Built-in frame aerial high quality, extremely sensitive and very adequate volume from the 5in. loudspeaker. Valve line-up: 3V4, 1R5, 1S5, 1T4. The complete kit, including cabinet, can be supplied from stock at the original special inclusive price of £7/7/- plus 2/6 p. & p. (less batteries). Uses Ever Ready 90 v. H.T. type B126 at 10/- and 1.5 v. L.T. type A.D.35 at 1/6. Instruction book available separately at 1/6 post free, contains easy-to-follow practical diagrams, circuit and individual component price list.
RAMBLER MAINS UNIT. Enabling the above receiver to be used on A.C. mains. Very easily fitted. Complete kit, when assembled, fits snugly into battery compartment. KIT PRICE 47/6. Assembled and tested 65/-. Both 1/6 p. & p. This unit is completely self-contained in metal box measuring 7in. × 2½in. × 1¼in., and is ideally suitable for most all-dry portables requiring 90 v. H.T. and 1.5 v. L.T. IMPORTANT: Please state valve line-up when ordering.

"FAMILY FOUR." Our new T.R.F. kit with handsome brown bakelite cabinet. This receiver gives results comparable to many commercially made receivers costing twice this price. ONLY £4/19/6 plus 2/6 p. & p. Instruction booklet available separately at 1/6 post free.

N.B.—All our T.R.F. Kit circuits include specially wound Denco "Max Q" coils on polystyrene formers. Improved performance. Price remains the same.

THE R.C. 2 AMP. BATTERY CHARGER KIT. Includes handsome well-ventilated stove-enamelled steel box, size: 7½in. × 3½in. × 3½in. Fully shrouded first quality transformer, brand new G.E.C. rectifier. Mains fuse, etc., for charging 6 or 12 v. batteries at 2 amp. Absolutely complete kit with full practical and theoretical instructions. Price 38/6 plus 2/6 P. & P. Can be supplied assembled and tested at 45/- plus P. & P. Heavy duty crocodile clips suitable for car battery lugs, optional extra at 1/6 per pair.

AT LAST!
LIMITED STOCKS ONLY
The Very Latest
COLLARO MK. IV
TAPE TRANSCRIPTOR

SUBJECT TO BEING UNSOLD. £22/10/- plus 7/6 C. & P., H.P. or CREDIT SALE TERMS AVAILABLE.
The COLLARO Pre-Amplifier and Power Pack for use with the above deck is also available in limited quantity at £21 plus 3/6 P. & P.

THE "ECONOMY FOUE" T.R.F. KIT. A three-valve plus metal rectifier receiver. A.C. mains 200/250 v. Medium and Long waves. We can supply all required components right down to the last nut and bolt. Valve line-up: 6K7, 6J7 and 6V6. Chassis ready drilled. Cabinet size 12in. long by 6in. high by 5in. deep. Choice of ivory or brown Bakelite or wooden walnut-finish cabinet. Complete instruction booklet with practical and theoretical diagrams. Each component brand new and tested prior to packing. Our price £5/10/- complete. Remember this set is being demonstrated at our shop premises. We proudly claim that our fully illustrated instruction booklet is the most comprehensive available for this type of receiver. Booklet available at 1/9 post free. This is allowed if kit is purchased later. Plus 2/6 packing and carr. for complete kit.

The R.E.P. 1-Valve RECEIVER. All dry battery operation, for use with headphones, the complete kit is available at 42/-, less battery, plus 2/- P. & P., or full instructions at 9d. post free.

GRAMOPHONE MOTORS are in SHORT SUPPLY

COLLARO AC 3/554. Three-speed single player for AC mains 200/250 v. Cream finish, complete with turnover crystal pick-up incorporating the well-known high output "T" type head. Strictly limited quantity at £6/19/6 plus 3/6 P. & P.

COLLARO 4-SPEED single record unit with separate pick-up and HGP59 crystal cartridge. Brand new, few only, £4/12/6 plus 3/6 P. & P.

FOUR-SPEED CHANGERS
Collaro RC456 Mixer Auto-Changer in cream with Studio "O" insert, £8/19/6. B.S.R. MONARCH. Mixer Auto-Changer, in cream and gold, £8/15/-. Both plus P. & P. 3/6. H.P. Terms available. Stocks rapidly diminishing.

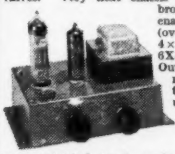
THE STAAR "GALAXY"

Four speed Mixer Auto-Changer. Finger-tip stop. Start and speed change control. Modern duo-tone finish. Beautifully made and moderately sized to fit almost any cabinet. For A.C. mains operation 110-250 v. Price £9/15/- incl. P.T. STAAR GALAXY complete with base £10/19/6 incl. P.T. Both plus 3/6 C. & P.

RECORD PLAYER CABINETS—to suit all types of single record and autochanger units. Price from 45/-. Send stamp for fully illustrated list.

PORTABLE GRAM AMPLIFIERS

RC1.A. AMPLIFIER. A small high quality gramophone amplifier employing the latest circuitry and highly efficient miniature valves. Very neat chassis finished in bronze stove enamel. Size: (overall) 5½ × 4 × 5in. Valves 6X4, ECL82. Output 3 watts max. Controls. Volume. Tone/On/Off. For use on AC mains 200/250 v.



Price £3/19/6 plus 2/- P. & P.

RC2A. Small PRINTED CIRCUIT single valve high gain amplifier for the smaller type of portable. Employs latest type ECL80 valve. Further details on request. Price only 59/6 plus 2/- P. & P.

RC3A. A superior quality 3-valve amplifier employing EZ80, EL84 and ECC83. With separate Bass and Treble controls. Further details on request. Price: £3/19/6 plus 2/6 P. & P.

RC4.A. (STALLION). This is supplied complete with high flux 8in. P.M. Speaker and Baffle. Incorporating three octal type valves 6Q7, 6V6 and 6X5, this robust and well-made unit is ideal for use in the larger type of record player and is equally suitable for use in conjunction with a radio feeder unit. Separate bass and treble controls are provided; also provision is made for an extension speaker and mains supplied to gram. motor. Output approx. 4 watts. Size overall 13in. × 4in. × 9in. high. For use on A.C. mains 100/200/250 v. PRICE £5/19/6 plus 2/6 P. & P. H.P. terms £2/19/6 deposit and four monthly payments of 16/6.
Fits our portable cabinet "G" at 85/- without modification.

SPECIAL OFFER TRANSFORMERS AND CHOKES. These are beautifully made, potted transformers and chokes by a well known manufacturer, that will put the "finishing touch" to any equipment with which they are used. All are absolutely brand new.
MAINS TRANSFORMERS:
(A) PRIMARY: 230 v. SECONDARY: 390-0-390 v. 150 mA. 2 v. 1.4 amp. 6.3 v. tapped 4.16 v. 9 am. 4.12 v. 4 amp. 5 v. 2 amp. Size 5½in. × 4½in. × 5½in. high. PRICE 45/-.
(B) PRIMARY: 110, 200, 230, 250 v. SECONDARY: 350-0-350 v. 130 mA. 2 v. 1.4 amp. 6.3 v. tapped 4.16 v. 9 amp. 4.12 v. 4 amp. 4 v. 2.2 amp. Size 4½in. × 5½in. × 5½in. high. PRICE 45/-.
(C) PRIMARY: 200, 230, 250 v. SECONDARY: 320-0-320 v. 180 mA. 4 v. 2.2 amp. 4 v. 6.2 amp. Size: 5½in. × 4½in. × 5½in. high. PRICE 20/-.
(D) PRIMARY: 200, 230, 250 v. SECONDARY: 290-0-290 v. 200 mA. 4 v. 2.2 amp. 6.3 v. tapped 4.2 v. 6.3 amp. Size 5½in. × 4½in. × 5½in. high. PRICE 35/-.
(E) PRIMARY: 110, 200, 230, 250 v. SECONDARY: 330-0-330 v. 100 mA. 4 v. 1.4 amp. 4 v. 6 amp. Size: 4½in. × 3½in. × 3½in. high. PRICE 17/6.
(F) PRIMARY: 200, 220, 230, 250 v. SECONDARY: 0 v. 6 amp. 2 v. 4 amp. 6 v. 3 amp. Size: 3½in. × 4in. × 3½in. PRICE 15/-.
CHOKES:
(G) 40H, 50 mA. Size 3½in. × 3½in. × 3½in. high. PRICE 10/6.
(H) 10H 100 mA. Size: 2½in. × 3½in. × 3½in. high. PRICE 15/-.
(I) 8H 100 mA. Size 3½in. × 3½in. × 3½in. high. PRICE 12/6.
(J) 6H. 150 mA. Size 2½in. × 2½in. × 3½in. high. PRICE 10/-.
(K) (Double choke) 3H. 60 mA. 4.5 H. 30 mA. Size: 2½in. × 2½in. × 3½in. high. PRICE 5/-.
OUTPUT TRANSFORMER:
(L) PRIMARY: 5K ohm (suit 6V6 single ended, etc.). SECONDARY: 2.6-3 ohms. Size: 2½in. × 2½in. × 3½in. high. PRICE 10/-.

VALVES. We have perhaps the most up-to-date valve stocks in the trade. A stamp will bring complete list of brand new imported valve types, fully guaranteed. P.T. paid. Also all usual surplus types available such as 6V6GT, etc.

CLYNE RADIO LTD.

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and at
162 Holloway Road, London, N.7

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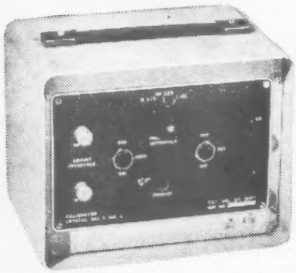
CRYSTAL CALIBRATOR

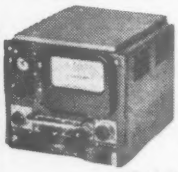
No. 7 Mark 2.
10 kc/s—100 kc/s—1 Mc/s.



Battery operated input 60 v. and 2 volt. Complete with 6 valves, 5-IT4 and IR5 and Xtal. and 'phones. This instrument is a modern version housed in small metal case. Brand New in transit case.

£5/19/6

INDICATOR UNIT TYPE "247"



Power Watt-meter comprising 4½in. rectangular 1 mA. Meter, Magic eye, 2-EF50 Diode and Rectifiers. 100/230 v. A.C. 50 cy. 80 v. and 12 v D.C.

£4/19/6

U.S.A. TESTMETER TYPE "834-S"

A.C./D.C. 15 RANGES

Complete in wooden carrying case with leads and internal batteries

A.C./D.C. Volts 12/60/300/600 v./1,200/6,000v
Milliamps 1.2/12/60/600 m/a.
Ohms 0-5000/5 meg. F.S.D. 1,000 o.p.v.

£6/19/6

WAVE-GUIDE WATTMETER

Type W8921 10 cm. Complete in transit case.
BRAND NEW **£5/10/-**

TEST SET 229

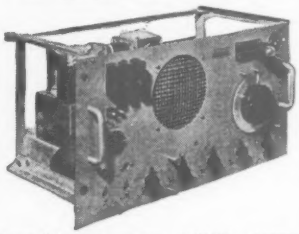
Admiralty type 600 Mc/s. Complete in transit case.
BRAND NEW **£5/10/-**

RT10/APS-3

3 Centimeter Radar Unit
Containing 725A Magnetron, 2—723A/B's, 2—6AC7's, 724A, IN23, magnet and pulse trans.
BRAND NEW IN CARTON **£10/10/-**

Sputnik Special

COMMUNICATION RECEIVER
SHORT-WAVE RECEIVER
10-60 Mc/s (5-30 Metres)
RECEPTION SET TYPE 208



Containing 6 valves, 2-6K8G, 2-EF39, 6Q7G and 6V6G, Metal rectifiers, built-in mains pack and 6v. Vibrator pack, built-in 6½in. speaker, Muirhead slow motion drive, B.F.O. and R.F. stage. 2 Mc/s I.F. freq. Provision for 'phones and muting and 600 ohm line.

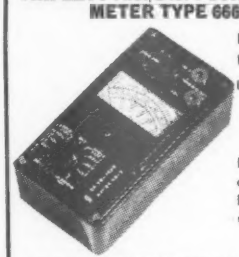
Dual input 100/250 v. A.C. and 6 volt D.C.

£6/19/6
Carr. 15/6.

Complete in metal transit case 24× 18× 12. Weight 80 lbs. In new condition and air tested.

BE PREPARED TO LISTEN TO THE SATELLITES

TRIPLETT A.C./D.C. POCKET TEST-METER TYPE 666H



15 ranges
1,000 ohm p.volt.

In new condition with Prods and Internal battery.

A.C./D.C 10/50/250/1,000/5,000 volts.
Milliamps 0-10/100/500.
Ohms 0-300/250,000 ohms.

£5/10/-

CATHODE RAY TUBES

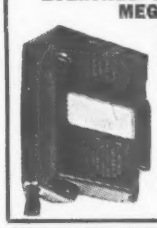
VCR138A with screen	£1	15	0
VCR139A	£1	15	0
VCR139A Mu-metal Screen.....		5	6
VCR97. Full T.V. picture (carr. 2/-)	£2	0	0
VCR517C. Full T.V. picture	£1	15	0
MU-METAL SCREENS for VCR97 or 517		10	0
VCR97. Slight-cut-off. Carr. 2/-.		15	0
3PB1. Brand new	£1	10	0

PIRANI HIGH-VACUUM TEST EQUIPMENT

with calibrator and galvo.

£33/10/-
SEND FOR BOOKLET.

EVERSHED 500 VOLT WEE-MEGGERS



Brand New 0-50 meg. with leather case and books in original packing.

£12/10/0

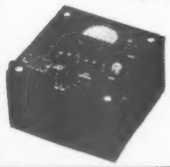
Used, in new condition with leather case,

£8/19/6

100 volt type with leather case.

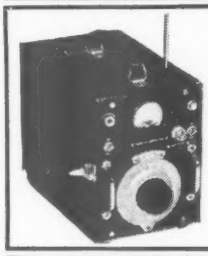
£6/0/0

U.S.A. R.F. WATTMETER TS/87/AP



Three position 0-10/15/30 w. Complete with photo-cell, 2 spare lamps and leads, with transit case.

BRAND NEW
£10/10/-



BC 906D FREQUENCY METER

Range 150-235 Mc/s. New condition.

£3/5/0

"373" MINIATURE IF STRIP 9.72 Mc/s

The ideal F.M. conversion unit as described in 'P.W.' April/May, 1957. Complete with 6 valves, three EF91's, two EF92's and one EB91, I.F.T.'s etc., in absolutely new condition. With circuit and conversion data.

12/6 (less valves) **42/6** (with valves).

Postage and packing 2/6 (either type).

WALKIE/TALKIE TYPE 38 TRANSMITTER/RECEIVER

Complete with 5 valves. In new condition. With circuit. These sets are sold without guarantee, but are serviceable. P.P. 2/6. **22/6**

H/phones 7/6 pair. Junction box 2/6. Throat mike 4/6. Canvas bag 4/-. Aerial Rod 2/6.

TRANSMITTER/RECEIVER ARMY TYPE 17 MK. II

Complete with Valves, High Resistance Headphones, Handmike and Instruction Book and Circuit.

Frequency Range: 44.0 to 61 Mc/s.
Range approximately: 3 to 8 miles.
Power requirements: Standard 120 v. H.T. and 2 v. L.T.
Ideal for Civil Defence and communications.

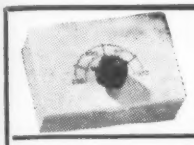
BRAND NEW **59/6**

Calibrated Wavemeter for same 10/- extra

Send 3d.—28 PAGE CATALOGUE CONTAINING BARGAINS IN VALVES, COMPONENTS AND METERS

HENRY'S RADIO LTD.

5, HARROW ROAD, PADDINGTON, W.2
(Opposite Edgware Road Station) PAD. 1008/9



CRYSTAL SET

Build this sensitive Crystal Set in 90 minutes. Complete Kit of Parts with Aerial and Earth Wire. Plastic Box. **17/6** P.P. 1/6.

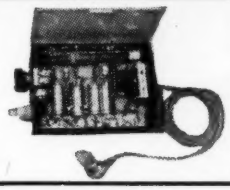
With High Resistance Phone, **29/6**. P.P. 1/6.

HEADPHONES

Low Resistance	7/6 pair
High Resistance	12/6 pair
Marconi Lightweight	10/- pair

"EAVESDROPPER" THREE TRANSISTOR POCKET RADIO

(No Aerial or Earth required)

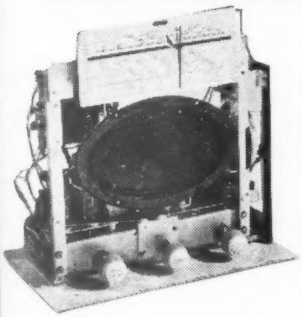


Variable tuning on medium waves. Total cost as specified, including Transistors, Transformers, Coils, Condensers and Battery, etc., with circuit and plastic case. All items sold separately. Full practical layout diagrams. ..... **77/6** post free.

With balanced armature earpiece **81/-**. With Acos Mike, **90/-**. With Min. Hearing Aid, **90/-**.

5-VALVE A.C./D.C. PORTABLE RADIO-GRAM CHASSIS THREE WAVE BAND SUPERHET, 250/250V A.C./D.C.

(With Internal Aerial)



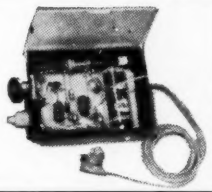
Short Wave 16-50 m. Medium Wave 187-575 m. Long Wave 900/2000 m. (With Gram. Switching.) 5 valves, type: X109, W107, DH107, N108 and U107 and 7 × 4 Elliptical Speaker. Ideal for Portable Radio-Gram. Chassis size: 10 × 4 × 4in.

£7/12/6

P.P. 7/6.

Also available as above at the same price, similar chassis with following specifications: Short Wave 11.27-31.9 m. Short Wave 31.2-91 m. Medium 187-575 m. and Gram. Switching.

"HOMELIGHT" TWO TRANSISTOR PERSONAL PORTABLE



Variable tuning. We can supply all components, including two Transistors, Diode, Resistors, Condensers and Miniature Hearing Aid and plastic case, size 4½ × 2¾ × 1¼in., and 1½-volt battery for **52/6**. Practical layout.

All items sold separately.

MINI-TWO TWO TRANSISTOR MINIATURE POCKET RADIO

The smallest Transistor set offered on the market. Variable tuning. Drilled chassis, plastic case 3 × 2 × ¾in., Miniature Hearing Aid, 2 Transistors and all components including 1½ volt battery, circuits and full practical layout diagrams. All components sold separately. **Total cost 49/6 complete.**

"TRANSISTOR—8"

Push-Pull Portable Superhet **CAN BE BUILT FOR £11/10/-.**

This Portable 8 Transistor Superhet is tunable for both Medium and Long Waves and is comparable in performance to any equivalent Commercial Transistor Set. Simplified construction enables this set to be built easily and quickly into an attractive lightweight cabinet supplied.

TEN STAR FEATURES

★ 8 Specially selected Transistors
★ 250 Milliwatts Output Push Pull
★ Medium and Long Waves
★ Internal Ferrite Rod Aerial
★ 7 × 4 Elliptical Speaker
★ Drilled Plastic Chassis 6½ × 2¾in.
★ Point to Point wiring and practical layout
★ Economical. Powered by 7½ v. battery
★ Highly sensitive
★ Attractive lightweight contemporary case

N.B.—Pair of XC101's supplied at additional cost of 40/-.

Call and hear demonstration model. Further details in the August issue of "Radio Constructor."

We can supply all these items including Cabinet for **£11/10/-**. All parts sold separately.

Send for circuit diagrams, assembly data, illustrations and instructions, and full shopping list **1/6**.

QUARTZ CRYSTALS

FT243—FUNDAMENTALS

80 Types 5706.667 Kc/s to 8340 Kc/s (in steps of 33.333 Kc/s).
120 Types 5675 Kc/s to 8650 Kc/s (in steps of 25 Kc/s).
(Excluding Types 7000/7300 and 8000/8300) 5/- each.

Complete Sets of 80 Crystals	£6	0	0
Complete Sets of 120 Crystals	£7	10	0

7000 Kc/s to 7300 Kc/s, in steps of 25 Kc/s } **7/6** each.
8000 Kc/s to 8300 Kc/s, in steps of 25 Kc/s }

FT241A—54th HARMONIC

80 types 20 Mc/s to 27.9 Mc/s. (In steps of 100 Kc/s.) (Excluding 24/25.9 and 27 Mc/s) ..... 5/- each.
24/25.9 & 27 Mc/s at **7/6**. Complete Set of 80 Crystals **£6**

100 Kc/s.	Gold Plated D.T. Cut 10X	15/-
100 Kc/s.	Two-Pin 10X	15/-
150 Kc/s.	Two-Pin Round	12/6
160 Kc/s.	Two-Pin 10X	12/6
200 Kc/s.	FT241A	10/-
500 Kc/s.	FT241A	7/6
500 Kc/s.	10X	15/-
500 Kc/s.	Brook's	15/-
2500 Kc/s.	Octal	12/6
5000 Kc/s.	Piezo Two-Pin	12/6

P.O. TYPE 4B CERAMIC

100 Kc/s. 819.6 Kc/s } **15/-** EACH
163.9 Kc/s. 1000 Kc/s. }

CERAMIC 2-PIN BANANA PLUG

15,010 Kc/s, 16,135 Kc/s, 16,435 Kc/s, 18,925 Kc/s, } **7/6** EACH
15,110 Kc/s, 16,335 Kc/s, 16,700 Kc/s, 18,125 Kc/s. }

MARCONI, S.T.C. 2-PIN10X FUNDAMENTALS IN KILOCYCLES

1544.4	1674.9	1815	2089	3280	4860	10,534	11,437
1561.1	1680	1870	2090	3310	10,166	10,545	11,501
1566.5	1680.5	1875	2118.25	33175	10,189	10,557	11,526
1566.75	1700	1930	2196	3390	10,233	10,567	11,587
1572.5	1727	1981	2261	3440	10,245	10,622	11,751
1579	1740	2012	2295	3630	10,300	10,755	11,788
1588.68	1761	2065	2312	3850	10,433	10,767	11,814
1613.25	1764.5	2065.75	2315	3920	10,445	10,823	11,851
1650	1775	2067.5	2430	3960	10,501	10,856	11,876
1668.2	1780	2087.5	3970	4210	10,511	10,878	12,685

at **7/6** each.

T.C.S. CRYSTALS. 3-PIN, IN KILOCYCLES

1522.5	1700	2070.3	2105	2667.5
1572.5	1962.5	2072.5	2410	2865
1665.5		at **7/6** each.		

FT241A 72nd HARMONIC CRYSTALS IN MEGACYCLES

32.5	32.7	36.4	36.6	at 5/-
32.6	36.3	36.5	36.7	each.

TRANSISTORS

JUNCTION TYPE P-N-P. (British Manufacture.)

RED-SPOT 800 Kc/s Audio Frequency	10/-
BLUE-SPOT 1.6 Mc/s Mixer and Frequency Changer	15/-
WHITE-SPOT 2.5 Mc/s R.F. and I.F. Amp.	20/-

All Transistors are Tested and Guaranteed. **N.B.—The Red-Spot is similar to Mullard OC71.**

FERRANTI TESTVAC. High speed Vacuum Tester, 200/250 A.C. **£10 10 0**

TRANSISTOR SIGNAL TRACER. Complete Kit with 2 Transistors, Components, Phones and Circuit and plastic case.... **42/6**

TRANSISTOR SQUARE WAVE GENERATOR. Complete Kit with 2 Transistors, Components, Circuit and plastic case. **25/-**

DIODES.

B.T.H. Germanium	1/6
Mullard OA74	2/6
IN21	3/6
IN22, IN23, IN21A	5/-

Over 300 different types B.V.A. and American VALVES in stock. Send for Lists.

MODEL-MAKERS' MOTORS. Two types available, 12 or 24 v., with ⅛in. spindle. **10/-** each.

6 v. VIBRATOR PACKS. Output 120 v. 30 m/a., **12/6**. Brand new.

RF24 **10/-**, RF25 **12/6**, RF26 **25/-**. Brand new with valves, carr. 2/6.

COLLARO RC456. 4 speed auto changer. Latest type with crystal turnover pick up. **£8/19/6**. P.P. 3/6.

HENRY'S RADIO LTD

5 HARROW RD., PADDINGTON, W.2

PADDINGTON 1008/9

OPEN MONDAY—SATURDAY 9-6. THURSDAY 9-1

XUM

BATTERY CHARGING EQUIPMENT

SELENIUM RECTIFIERS

L.T. Types

2/6 v. ½ a.h.w.	1/9
6/12 v. ½ a.h.w.	2/9

F.W. Bridge

6/12 v. 1 a. ..	4/11
6/12 v. 2 a. ..	9/9
6/12 v. 3 a. ..	11/9
6/12 v. 4 a. ..	14/9
6/12 v. 6 a. ..	19/9
6/12 v. 10 a.	25/9

H.T. Type H.W.

120 v. 40 mA.	3/9
250 v. 50 mA.	5/9
250 v. 80 mA.	7/9
250 v. 150 mA.	9/9
300 v. 250 mA.	12/11

ASSEMBLED CHARGERS

6 v. 1 a.	19/9
6/12 v. 1 a.	27/9
6 v. 2 a.	29/9
6/12 v. 2 a.	38/9
6/12 v. 4 a.	56/9

Above ready for use with mains and output leads. Cases well ventilated and finished in stoved blue hammer. Carr. and packing. 3/6.

BATTERY CHARGER KITS

Consisting of Mains Transformer F.W. Bridge. Metal Rectifier, well ventilated steel case. Fuses, Fuse-holders, Grommets, panels and circuit. Carr. 2/6 extra.

6 v. or 12 v. 1 amp. ..	22/9
6 v. 2 amps	25/9
6 v. or 12 v. 2 amps. ..	31/6
6 v. or 12 v. 4 amps. ..	53/9

BATTERY CHARGER KIT Consisting of F.W. Bridge Rectifier 6/12 v. 5 a. Mains Trans. 0-9-15 v. 6 a. output, and ammeter. Only 49/9. Post 3/-.

ASSEMBLED CHARGER

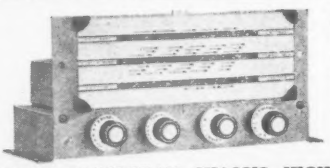
6 v. or 12 v. 2 amps.

Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only 49/9. Carr. 3/6.

All for A.C. Mains 200-250v., 50 c/s. Guaranteed 12 months

Assembled 6v. or 12v. 4 amps.

Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. Carr. 3/9. Or Deposit 30/- and four monthly payments 13/-. **75/-**



AM/FM RADIOGRAM CHASSIS, HIGH QUALITY. PUSH PULL. 6-8 WATTS OUTPUT

Current manufacture. 12 months' guarantee. For 200-250 v. mains. Covers L and M. Wavebands plus F.M. Includes 8 latest type miniature B.V.A. valves. Only 22 **gns.** plus 7/6 carr. Or deposit £2/12/- and 9 monthly payments of £2/12/-. Guaranteed 12 months.

CO-AXIAL CABLE. 75 ohms, ¼in., **8d.** yard. Twin screened feeder **11d.** yard.

ELECTROLYTICS (current production) Not Ex-Govt.

Tubular Types		Can Types	
8 mfd. 450 v.	1/9	16 µF 450 v. ..	2/9
8 mfd. 500 v.	2/6	16 mfd. 500 v.	3/9
16 µF 350 v. ..	1/11	32 µF 350 v. ..	2/11
16 µF 450 v. ..	2/9	32 mfd. 450 v.	4/9
16 µF 500 v. ..	3/9	100 mfd. 450 v.	4/9
8-16 µF 500 v.	4/11	8-8 µF 450 v. ..	2/11
25 µF 25 v. ..	1/3	8-16 µF 450 v.	3/11
50 µF 12 v. ..	1/3	16-16 µF 450 v.	3/11
50 mfd. 25 v. ..	1/9	32-32 µF 350 v.	4/9
50 µF 50 v. ..	1/9	32-32 µF 450 v.	5/9
100 mfd. 12 v.	1/9	100-100 mfd. 350 v.	5/9
100 mfd. 25 v.	2/3	64-120 mfd. 350 v.	7/6
3,000 mfd. 6 v.	3/9	100-200 mfd. 275 v.	6/11
6,000 mfd. 6 v.	3/11		

Many others in stock.

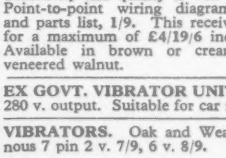
VOLUME CONTROLS with long spindles, all values, less switch, 2/9; with S.P. switch, 3/9.

EX GOVT. STEP UP/STEP DOWN TRANSFORMERS. Double wound 80/100 watts. 10-0-100-200-220-240 v. to 5-0-75-115-125-135 v. or Reverse. Only 11/9 plus 2/9 post 10-0-100-200-220-240 v. to 9-0-110-122-136-148 v. or Reverse. 300 watts, 35/9, plus 7/6 carr.

EX GOVT. METAL BLOCK PAPER CONDENSERS

4 mfd. 350 v. ..	2/3
4 mfd. 1,000 v...	3/9
8 mfd. 500 v. ..	4/6
10 mfd. 500 v.	3/9

THE SKY FOUR T.R.F. RECEIVER



A design of a 3 valve 200-250 v. A.C. Mains L. & M. wave T.R.F. receiver with selenium rectifier. For inclusion in cabinet illustrated or walnut veneered type. It employs valves 6K7, SP61, 6F6G, and is specially designed for simplicity in wiring. Sensitivity and quality is well up to standard. Point-to-point wiring diagrams, instructions and parts list, 1/9. This receiver can be built for a maximum of £4/19/6 including cabinet. Available in brown or cream bakelite, or veneered walnut.

EX GOVT. VIBRATOR UNITS. 12 v. input 280 v. output. Suitable for car radio, etc., **16/6.**

VIBRATORS. Oak and Wearite. Synchronous 7 pin 2 v. 7/9, 6 v. 8/9.

EX. GOVT. 50 WATT AMPLIFIERS. Brand new. For 200-250 v. 50 c.p.s A.C. mains. Designed for speech only but with suitable pre-amp, could be used with Gram. or Radio. Valves included. Four 6L6s used for output. Complete with hand microphone with good length of lead. Unused in original transit cases. Only 9 **gns.** Ready for use. Carr. 15/-.

RE-ENTRANT SPEAKERS. Tannoy 8 watt, 7.5 ohms suitable for above, 25/- each.

EX GOVT. MAINS TRANSFORMERS

All 200-250 v 50 c/s. input.

120-0-120 v. 40 mA.	5/9
250-0-250 v 60 mA., 6.3 v. 3 a., 6.3 v. 1 a. Potted 4½-3½-3in.	11/9
Pr. 0-110-200-230-250 v., 275-0-275 v. 100 mA., 6.3 v. 7 a., 5 v. 3 a.	21/9
230-0-230 v. 80 mA., 12.6 v. 1.5 a. 5 v. 2 a.	11/9
250-0-250 v. 150 mA. 5 v. 3 a.	16/9
350-0-350 v. 160 mA. 6.3 v 5 a. 5 v. 3 a.	27/9
400-0-400 v. 250 mA. 5 v. 2 a., 5 v. 2 a.	18/9
450-0-450 v. 150 mA. 6.3 v. 5 a., 6.3 v. 1 a., 5 v. 3 a.	29/9
450-0-450 v. 250 mA. 6.3 v. 3 a., 6.3 v. 1 a., 5 v. 6 a.	49/9
12.5 v. 3 a., 5 v. 3 a.	12/9

MANUFACTURERS' SURPLUS TRANSFORMERS. Primary 200-240-250 v. Drop through type 250-0-250 v 70 mA. 6.3 v. 3 a., 11/9. Postage 2/9

EX GOVT. SMOOTHING CHOKES

300 mA., 20 H., 150 ohms	19/6
250 mA., 5 H., 50 ohms	12/9
150 mA., 10 H., 50 ohms	10/11
100 mA., 10 H., 100 ohms	6/9
100 mA., 5 H., 100 ohms, tropicalised ..	3/11
80 mA., 10 H., 350 ohms, tropicalised ..	3/11
50 mA., 50 H., 1,000 ohms	6/9

EX GOVT. CASES. Well ventilated, black crackle finished, undrilled cover. Size 14 × 10 × 8½in. high. IDEAL FOR BATTERY CHARGER OR INSTRUMENT CASE, COVER COULD BE USED FOR AMPLIFIER. Only 9/9, plus 2/9 post, Size 13½in. × 8in. × 6½in. with undrilled perforated cover finished in stoved grey enamel, 7/9, plus 2/9 post.

SPECIAL OFFERS. Small 2 gangs .005 mfd., 4/9. Electrolytics 32-32-32 mfd. 250 v., 2/9 each or in lots of six, 2/3 each.

R.S.C. BATTERY TO MAINS CONVERSION UNITS

Type BM1. An all dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types. Complete kit with diagram. 39/9 or ready for use 46/9.

Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v., 90 v., and 60 v., 40 mA. and 2 v. 0.4 a. to 1 amp. fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T.2v.ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions, 49/9, or ready for use,, 59/6.

JUNCTION TRANSISTORS For R.F. 17/6.

MINIATURE MOTORS. 24/28 v. D.C. A.C. Size only 2½ × 1½in. Spindle 1½in. long, ¼in. diam. Made by Hoover Ltd., Canada. Price only 9/9.

M.E. SPEAKERS. 2-3 ohms R.A. 8in. Field 600 ohms., 11/9.

R.S.C. TRANSFORMERS

FULLY GUARANTEED. INTERLEAVED AND IMPREGNATED.

MAINS TRANSFORMERS

Primaries 200-230-250 v. 50 c/s.

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250 v. 60 mA., 6.3 v. 2 a., 5 v. 2 a.	17/6
350-0-350 v. 70 mA., 6.3 v. 2 a., 5 v. 2 a.	19/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
250-0-250 v. 100 mA., 6.3 v. 6 a., 5 v. 3 a., for R1355 conversion	31/-
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	25/9
300-0-300 v. 130 mA., 6.3 v. 4 a., c.t., 6.3 v. 1 a., suitable for Mullard 510 Amplifier	33/9
375-0-375 v. 150 mA., 6.3 v. 4 a., 5 v. 2 a.	29/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	33/9
350-0-350 v. 150 mA., 6.3 v. 2 a., 6.3 v. 2 a., 5 v. 3 a.	33/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 6.3 v. 4 a., c.t., 5 v. 3 a., suitable Williamson Amplifier, etc.	49/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-260 v. 70 mA., 6.3 v. 2 a., 5 v., 2 a.	16/9
350-0-350 v. 80 mA., 6.3 v. 2 a., 5 v. 2 a	18/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	22/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 5 v. 3 a.	23/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 5 v. 3 a.	29/9

ELIMINATOR TRANSFORMERS

Primaries 200-250 v. 50 c/s.

120 v. 40 mA., 5-0-5 v. 1 a.	14/9
90 v. 15 mA., 6-0-6 v. 250 mA.	9/11

FILAMENT TRANSFORMERS

Primaries 200-250 v. 50 c/s.

6.3 v. 1.5 a.	5/9	6.3 v. 3 a.	8/11
6.3 v. 2 a.	7/6	6.3 v. 6 a.	17/6
0-4-6.3 v. 2 a. ..	7/9	12 v. 3 a. or	
12 v. 1 a.	7/9	25 v. 1.5 a. ..	17/6

CHARGER TRANSFORMERS

All with 200-230-250 v. 50 c/s. Primaries:
0-9-15 v. 1½ a., 11/9; 0-9-15 v. 3 a., 16/9; 0-3.5-9-17 v. 3 a., 17/9; 0-9-15 v. 5 a., 19/9; 0-9-15 v. 6 a., 23/9.

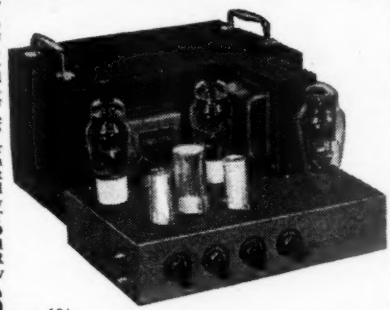
OUTPUT TRANSFORMERS

Midget Battery Pentode 66:1 for **3S4,** etc.	3/6
Small Pentode 5,000 Ω to 3 Ω	3/9
Standard Pentode, 5,000 Ω to 3 Ω	4/6
Standard Pentode, 8,000 Ω to 3 Ω	4/9
Push-pull 8 watts 6V6 to 5 ohms	8/9
Push-pull 10-12 watts 6V6 to 3 Ω or 15 Ω	15/9
Push-pull 10-12 watts to match 6V6 to 3-5-8 or 15 Ω	16/9
Push-pull EL84 to 3 or 15 ohms	16/9
Push-pull 15-18 watts, sectionally wound, 6L6, KT66, etc., to 3 or 15 ohms	21/9
Push-pull 20 watt high-quality sectionally wound, 6L6, KT66, etc. to 3 or 15 Ω	47/9

SMOOTHING CHOKES

250 mA., 5 H., 100 ohms	11/9
150 mA., 7-10 H., 250 ohms	11/9
100 mA., 10 H., 200 ohms	8/9
80 mA., 10 H., 350 ohms	5/6
60 mA., 10 H., 400 ohms	4/11
1 amp. 0.5 ohm. L.T. type	6/6

R.S.C. A10 ULTRA LINEAR 30 WATT AMPLIFIER



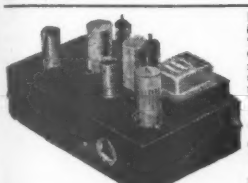
HIGH FIDELITY PUSH-PULL UNIT EMPLOYING SIX VALVES. EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-amp stages are incorporated. Sensivitity is extremely high. Only 12 millivolts minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associated vol. control is provided so that two separate inputs such as "mike" and gram., etc., etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20 mA. and 6.3 v. 1.5 a. FOR A RADIO FEEDER UNIT.** Price in kit form with easy-to-follow wiring diagrams. Cover as illustrated 18/9 extra.

Only **£10/19/6** carr. 10/-

Or Factory built with 12 months' guarantee **£13/13/-.** **TERMS ON ASSEMBLED UNITS. DEPOSIT 36/-** and 9 monthly payments of 31/-.

Type 807 output valves are used with High Quality Sectionally wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B., 30-20,000 c/cs., Tone Controls ± 12 D.B. at 50 c/cs., + 12 D.B. to — 6 D.B. at 12,000 c/cs., Hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish blue hammer. Overall size 12 × 9 × 9in. approx. Power consumption 150 watts. For A.C. mains 200-230-250 v. 50 c/cs. Outputs for 3 and 15 ohm speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS, or OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc. etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers.**

EXPORT ENQUIRIES INVITED



LINEAR LT/45 HIGH QUALITY TAPE DECK AMPLIFIER COMPLETE with POWER PACK and OSC. STAGE. Suitable for Collaro, Lane, Truvox, Aspden, Brennell, etc., etc. State make of Deck when ordering. Chassis size 12-7-3in. **Overall size 12-7-6½in. For 200-250 v. 50 c/cs. A.C. mains.** Output for standard 2-3 ohm speaker. **Only 15 millivolts input** required for full recording. Only 2 millivolts minimum output required from recording head. Magic Eye recording level indicator. Provision for feeding P.A. amplifier. Negative feed-back equalisation. **Linear frequency response** ± 3 D.B 50-11,000 c/cs. Facilities for recordings at 15in., 7½in or 3¾in. per second. Automatic equalisation at the turn of a knob. When switching from record to playback position automatic demagnetisation of heads is assured. Separate gain and output controls. Valves type ECC83, ECC83, EL84, EZ80, EM34. Output 4 watts. Unit supplied with maker's 12 months' guarantee. We know of no other make which represents the same exceptional value. Leaflet 6d.

12 GNS. Ready for use Carr. 7/6.

COLLARO JUNIOR 4 SPEED RECORD PLAYER with separate pick-up having dual point sapphire styli. Brand new, cartoned. For 200-250 v. A.C. mains only **£4/12/6.** Carr. 3/6.

STAAR GALAXY 4-Speed Auto-changers. Brand New For A.C. mains 110-200-250, 50 r.p.s. **9 GNS.** Carr. 4/6

LG3 MINIATURE 3 WATT GRAM. AMPLIFIER For 200-250 v. 50 c.p.s. A.C. Mains. Overall size only 6¾ × 4¾ × 2¾in. Fitted vol. and Tone Control with mains switch. Designed for use with **any** kind of single player or record changing unit. Output for 2-3 ohms speaker. Guaranteed 12 months. Only **55/9.**

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high-fidelity pick-up heads in addition to all other types of pick-ups and practically all mikes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum level is negligible being 71 D.B. down. 15 D.B. of negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish, and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-,** or assembled ready for use **25/-** extra, plus 3/6 carriage. Or Deposit **22/-** and five monthly payments of **22/-** for assembled unit.

R.S.C. A7 3-4 WATT QUALITY AMPLIFIER

A highly sensitive 4-valve amplifier using negative feedback and having an excellent frequency response. Pre-amplifier and Tone Control stages are incorporated with separate Bass and Treble controls giving full tone compensation for long playing records. Suitable for any kind of pick-up including latest high fidelity types. H.T. of 250 v. 20 mA and L.T. 6.3 v. 1 a, available for supply of Radio Feeder Unit, etc. ONLY 40 millivolts input required for full output. Fully isolated chassis with baseplate. For A.C. mains 200-250 v. 50 cycles. Output for 2-3 ohm speaker. Complete kit of parts with point-to-point wiring diagrams and instructions. Only **£3/15/-,** carr. 3/6 or factory built **22/6** extra.

COLLARO 4-SPEED AUTO-CHANGERS

With studio pick-up with turnover head. BRAND NEW. Cartoned, latest model. For 200-250 v. A.C. mains. Very limited number. Conquest **£8/19/6.** Continental **9 Gns.** Carr. 5/6.

COLLARO RC54 3 SPEED AUTO-CHANGER

As above unit but for normal 3-speed requirements. Brand new cartoned but for 110 v. 50 c.p.s. A.C. mains. So that the unit can be operated from normal 200-250 v. A.C. mains we are supplying free with every changer a suitable auto-transformer with input and output voltages clearly marked. Limited number only. **7 gns.** Carr 5/6.

PORTABLE CABINETS. Exceptionally attractive design. Finished in 2 tone rexine. Provision for speaker and amplifier. Inside dimensions 17½ × 12½in. Depth 7in. plus lid 1½in. Carriage 5/-. **69/6**

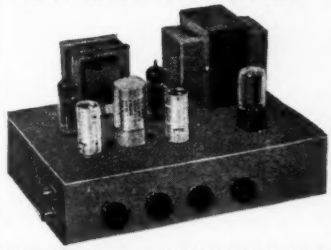
SPECIAL OFFER. Above cabinet LG3 Amplifier 6½in. spkr. and Collaro Junior **10 GNS.** or with Staar Galaxy 4-Speed Mixer Changer, **14 GNS.** Carr. 8/6.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with Garrard B.S.R. or any other record playing unit and most microphones. Total negative feedback 12 D.B. Separate Bass and Treble controls. For A.C mains input of 200-250 v. 50 c.p.s. Output for 2/3 ohm speaker. Three miniature Mullard valves used. Size only 6 × 5 × 5in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **£5/19/6.** Or Deposit **22/-,** and five monthly payments of **22/-.** Send S.A.E. for leaflet.

PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker of orthodox design supporting a small elliptical speaker ready wired with choke and condensers to act as tweeter. This high fidelity unit is highly recommended for use with our A11 or any similar amplifier. Rating is 10 watts. Gauss 12,000 lines. Price only **£5/17/6.** Or Deposit **13/-** and nine monthly payments of **13/-.**

A11 ULTRA LINEAR 12-14 WATT AMPLIFIER



NEW 1958 DESIGN HIGH-FIDELITY PUSH-PULL AMPLIFIER WITH "BUILT-IN" TONE CONTROL PRE-AMP. STAGES

Two input sockets with associated controls allow mixing of "mike" and gram. as in A10. High sensitivity. Includes 5 valves, ECC83 ECC83, EL84, EL84, 5Y3. High Quality sectionally wound output transformer specially designed for Ultra Linear operation, and reliable small condensers of current manufacture. **INDIVIDUAL CONTROLS FOR BASS AND TREBLE** "Lift" and "Cut" Frequency response ±3 DB 30-30,000 c/cs. Six negative feedback loops. Hum level 60 DB down ONLY 25 millivolts INPUT required for **FULL OUTPUT.** Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs. For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS** etc. **OUTPUT SOCKET** with plug provides 300 v. 30 m.a. and 6.3 v. 1.5. a. For supply of a **RADIO FEEDER UNIT.** Size approx. 12-9-7in. For A.C. mains 200-230-250 v. 50 c/cs. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied.

Only **8 GNS.** or factory built **45/-** extra. Carr. 10/-. If required louvred metal cover with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 25/6** and nine monthly payments of **25/6.** Send S.A.E. for illustrated leaflet detailing Ready-to-assemble Cabinets, Speakers, Microphones etc., with cash and credit terms.

LINEAR "DIATONIC" 10-WATT HIGH FIDELITY AMPLIFIER. Incorporating pre-amp. For A.C. mains input 200-230-250 v. 50 c.p.s. A compact attractively finished unit with two separately controlled inputs and outputs for 3 and 15 ohms speakers. Separate Bass and Treble controls. Five latest type miniature Mullard valves. Only **12 Gns.** Send S.A.E. for leaflet and credit terms.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012, 10 watts 15 ohm (or 3 ohm) speech coil. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/10/9.** Please state whether 3 ohm or 15 ohm required.

P.M. SPEAKERS. 2-3 ohm 5in. Goodmans **17/9.** 7 × 4in Elliptical **19/9,** 6½in. Rola, **19/9,** 8in. Rola, **19/9,** 8in. Goodmans **21/9.** 10in. R.A., **28/9.** 10-6in. Elliptical **28/9.** 12in. Plessey **29/11.** 12in. Plessey 3 ohms 10 watts, 12,000 lines, **59/6.**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner Unit (specially suitable for use with any of our Amplifiers). A Triode Heptode F/changer is used, Pentode I.F. and double Diode Second Detector, delayed A.V.C. is arranged so that A.V.C. distortion is avoided. The W Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch., and Vol. Output will load most Amplifiers requiring 500 mW. input depending on Ae location. Only 250 v. 15 mA. H.T. and L.T. of 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost is **£4/15/-.** Point-to-point wiring diagrams and instructions, **2/6.**

Radio Supply Co. (LEEDS) LTD.

32 THE CALLS. — LEEDS, 2.

Terms: C.W.O. or C.O.D. No C.O.D. under £1. Postage 1/9 extra an all orders under £2. 2/9 extra under £5 unless carriage charge stated. Full Price List 6d. Trade List 5d. Open to Callers: 9 a.m. to 5.30. p.m. Saturday until 1 p.m. S.A.E. please with all enquiries.

G.W. SMITH & CO (RADIO) LIMITED

Phone: GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

AVO MINOR LEATHER CASES. Brand new 7/6 each. P/P 1/-.

AVO MODEL 7 MULTIPLIERS. Extends 1,000-volt range to 4,000 volts. New, boxed, 5/6 each. P/P. 1/-.

MUIRHEAD VERNIER DRIVES. Brand new 7/6 each. P/P. 1/-.

U.S.A. RADIO CITY VALVE TESTERS. Brand new and unused, complete with instructions. 110/230 v. A.C. operation. Will test most type valves **£8/19/6 each.** P/P. 5/-.

FURZEHILL CRYSTAL CALIBRATORS. Includes 6 valves and 1 mc/s. Xtal, giving pips at 10,100 and 1,000 kc/s. Battery operated, 2 v. and 120 v. Brand new and boxed **59/6** each. P/P. 3/6.

W.1191 WAVEMETERS. Portable precision battery operated frequency check meters, coverage 100 kc/s. to 20 mc/s. Supplied complete with all valves and 1 mc/s. Xtal and calibration charts. **£5/19/16** each. P/P. 6/-.

TAYLOR MODEL 160A OUTPUT METER. incorporates 4in. meter calibrated 0-25 mW. Meter multiplier, .01-.1-1.0-10-100. Impedance matching, 2.5-5-100-125-150-600-4,000-8,000-10,000-20,000 ohms. Supplied brand new, boxed and tested, **£14/10/-** each. P/P. 5/-.

AUDIO BEAT FREQUENCY OSCILLATORS. Frequency coverage 0 to 10 kc/s., with separate 50 cycle check point. O/P impedance 10 or 600 ohms. Built-in monitoring voltmeter. Operation 110/200/250 volts A.C. Not new but. supplied in good working order. **£9/19/6** each P/P. 10/-.

MARCONI VALVE VOLTMETER TF.428B/1. 5 ranges, .10 to 150 v. Brand new in original transit cases with spares. **£22/10/-** each. P/P. 7/6.

WAYNE KERR INSULATION TEST SETS. No. 5. 200/250 v. A.C. operation, giving a variable output of 1 KV. to 5 Kv. A.C. or D.C., calibrated on 4in. meter. Supplied in good working order complete with EHT probes. **£9/19/6** each. P/P. 10/-.

MARCONI TF-643 SUB-STANDARD WAVEMETERS. Frequency coverage 20 to 300 mc/s. in 4 bands. Supplied as new with all coils and calibration charts. **£19/10/-** each. P/P. 6/-.

TRIPLETT 4in. 100 MICRO-AMP METERS. Square face, flush fitting. Already scaled ohms, volts and m/a.s. Ideal for test meter, new, boxed at **£3/19/6** each, P/P. 1/6.

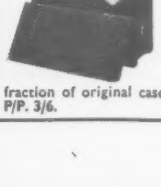
SPECIAL OFFER

OF MARCONI SIGNAL GENERATORS TF-517. Frequency coverage 16 to 58 mc/s. and 150 to 300 mc/s. Operation 200/250 volts A.C. Supplied in good condition at the ridiculous price of **£12/10/-** each. P/P. £1.

R.1155 COMMUNICATION RECEIVERS. New issue, in new condition, fitted with super slow motion drive. Supplied thoroughly checked and reception tested. **£8/19/6** each. P/P. 6/-.

R.1155 SUPER SLOW MOTION DRIVES. Improved version as fitted to Model L and N. Suitable for Model A, etc. Brand new **12/6** each. P/P. 1/-.

PORTABLE PRECISION VOLTMETERS



Brand new and boxed instruments by famous manufacturer. Housed in polished teak case. Moving iron movement reading A.C. or D.C. volts on 2 ranges. 0-160 v. and 0-320 v. 8in. mirror scale. Accuracy within 2%. Supplied at a fraction of original case. Only **£5/19/6** each. P/P. 3/6.

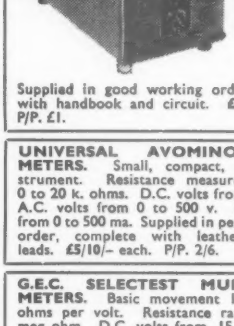
AMERICAN MULTI-RANGE TEST-METERS. 1,000 ohms per volt. 400 micro-amp basis movement. Ranges: volts, A.C. or D.C. 2.5, 10, 50, 250, 1,000 and 5,000 v. D.C. current. 1 ma., 10 ma., 100 ma. and 1 amp. Ohms. 500, 100 k. and 1 meg. Decibels, −10 to +69. The instrument is housed in polished wood case complete with test prods and instructions. As new, tested before despatch. **£5/19/6** each. P/P. 3/-.

AVOMETER MODEL D. Another large series Avo. Incorporates 10 D.C. volt ranges, 150 mv. to 1.5 kv. 8 A.C. volt ranges, 7.5 v. to 1.5 kv. 8 D.C. current ranges, 15 ma. to 30 amps. 6 A.C. current ranges, 75 ma. to 15 amps. Resistance ranges, 1 k. and 10 k. Supplied in perfect order, with instructions and leads. **£8/19/6** each. P/P. 4/-.

WESTON MODEL 722 TESTMETER. An ideal bench or portable instrument. Incorporates 5 A.C. or D.C. volt ranges, 2.5 v. to 1,000 volts. 6 D.C. current ranges, 100 microamp to 500 m/a. A.C. current, 500 ma., 1 amp., 5 amps. Resistance, 100 ohms, 1 K., 100 K. and 10 meghom. Supplied thoroughly tested in rexine covered carrying case with instructions and leads. **£10/10/-** each. P/P. 4/-.

EVERSHED AND VIGNOLES MEGGER LOW OHMS METER. The ideal meter for all circuit tests, continuity and polarity tests. Supplied brand new, unused, complete with leads, only **59/6** each. P/P. 3/-.

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 339



Operation 110/200/250 volts. A.C. 120 watts. Time Base 10 positions. 6 cps. to 250,000 cps. Amplifier 10 cps. to 2,000,000 cps. Sensitivity, Y1.Y2.3.1 v. D.C. 1.1 v. rms. X. 2.25 v. D.C. .8 v. rms.

Supplied in good working order, complete with handbook and circuit. **£27/10/-** each. P/P. £1.

UNIVERSAL AVOMINOR TEST-METERS. Small, compact, accurate instrument. Resistance measurements from 0 to 20 k. ohms. D.C. volts from 0 to 500 v. A.C. volts from 0 to 500 v. D.C. current from 0 to 500 ma. Supplied in perfect working order, complete with leather case and leads. **£5/10/-** each. P/P. 2/6.

G.E.C. SELECTEST MULTI-RANGE METERS. Basic movement 1 ma. 1,000 ohms per volt. Resistance ranges, 0 to 1 meg ohm. D.C. volts from .15 v. to 1.5 kv. A.C. volts from 7.5 v. to 1.5 kv. A.C. current from 75 ma. to 15 amp. D.C. current from 1.5 ma. to 30 amp. Incorporates safety cut-out. Supplied in perfect working order, complete with leads. **£9/19/6** each. P/P. 3/6.

EVERSHED AND VIGNOLES WEE MEGGER 500 VOLTS. Special release, brand new and unused, complete with leather carrying case, only **£12/10/-** each. P/P. 2/6. Also avilable, secondhand models, but perfect working order, complete with leather case, **£8/10/-** each. P/P. 2/6.

I.F. ALIGNMENT OSCILLATORS A laboratory instrument, three ranges 455, 465 and 475 kc/s., with dial readings of ±10 kc/s. on each range. 465 kc/s. crystal check. 30% internal modulation at 150 or 400 cycles. Variable attenuation from .1 microvolt to 1 volt, 1 DB to 100 DB. 200-250 volt A.C. operation, supplied brand new, boxed, **£15** each, P/P. 10/-.

CAMBRIDGE INSTRUMENTS CURRENT TRANSFORMERS. Input 50 cycles, 300, 150 or 75 amps. Output 15 amps 2.5 KVA. Brand new and boxed. **£4/19/6** each. P/P. 4/-.

ADVANCE CONSTANT VOLTAGE TRANSFORMERS. Input 190 to 260 volts. A.C. 50 cycles. Output constant at 230 volts. Max. rating 150 watts. Supplied brand new in original crates. **£8/10/-** each. P/P. 5/-.

METER BARGAINS

50 microamp, 2½in. P.J.M.C.	49/6
100 microamp, 2½in. f.m.m.c.	39/6
500/0/500 microamp, 3½in. F.M.M.C.	49/6
500/0/500 microamp, 2½in. P.J.M.C.	19/6
50/0/50 microamp, 2½in. F.M.M.C.	69/6
1 ma., 2½in. F.M.M.C.	25/-
1/0/1 ma., 2in. M.C.F.M.	15/-
200 ma., 2½in. F.M.M.C.	9/6
1 amp., 2½in. F.M.M.C.	10/6
1.5 amp., 2in. F.M.M.I.	6/6
7.5 amps. 3½in. PJMI.	10/6
300 volt A.C., 2½in. F.M.M.I.	25/-
4 KV. electrostatic, 3½in. F.M.	59/6

MARCONI 10CM. SIGNAL GENERATOR. Consisting of signal generator and power supply unit TF-854 and TF-853. Frequency coverage 9.1 to 10.7 centimetres. Operation 200/250 volts A.C. Supplied brand new in original transit cases with instructions. **£100** each. P/P. £2.

BENDIX COMMAND TRANSMITTERS. Complete with all valves and Xtal. Frequency coverage 2.1 to 3 mc/s. Only **22/6** each. P/P. 2/6.

AVO BATTERY ELIMINATOR POWER PACKS. Operation 200/250 volts A.C. Output 1.4 volts at 300 ma. and 67 volts at 10 ma. Stabilised by VS70, whole unit fully fused. Size 8½in. x 5in. x 3½in. Ideal for personal battery sets, etc., supplied brand new in maker's cartons. **39/6** each. P/P. 2/6.

5FT. P/O RACKS. Standard 19in., "U" channel. **59/6** each. P/P. 12/6

AMERICAN COMBINED VALVE TESTER AND MULTI-RANGE TEST-METERS. Brand new and boxed, complete with carrying case and instructions. Will test all standard American type valves and incorporates on the same panel a multi-range meter with the following ranges: 0-1 KV. A.C./D.C., 0-10 megohms resistance, 0-500 m/a. D.C. current, 0-100 mfd. capacity. Only **£14/17/6**, P/P. 7/6.

SPECIAL OFFER

BRAND NEW AMERICAN/CANADIAN No. 19 Mk. II TRANSMITTER-RECEIVERS. Complete with all valves. Frequency coverage 2 to 8 mc/s. **65/-** each. P/P. 10/-.
Limited number only available.

POST OFFICE TELEPHONE HANDSETS. Standard type, brand new and boxed, **12/6** each. P/P. 1/3.

AMERICAN TRIPLETT MULTI-RANGE TESTMETERS. A small compact instrument with the following ranges: volts A.C. 10 to 1 KV. Volts D.C. 10 to 1 KV. Current D.C. 10 ma. to 500 ma. Resistance 300 ohms to 250 k. ohms. Supplied in perfect working order complete with leads. **£4/17/6** each. P/P. 2/6.

AMERICAN DESK TELEPHONES. Complete units with handsets, bells and junction box. No dials, but can be fitted. Can be used on normal G.P.O. lines. Supplied brand new and boxed, **59/6** each. P/P. 3/-. English type also available, but with green handset, **49/6** each.

JOHNSON TX. CONDENSERS. Brand new and boxed, 500 pf. variables. **15/6.** P/P. 1/-. Also new, boxed, 2½in. variable inductances by Johnson. **22/6.** P/P. 2/6.

AR.88 WAVECHANGE SWITCHES. Spare for Model D. Ceramic, 8 bank, 6 pos., complete with all screens. Brand new. **17/6** each. P/P. 2/6.

2-VOLT 3 A.H. ACCUMULATORS. Exide, brand new, unfilled, 2/- each. P/P. 9d. Block of 12, wired as 24 v., **21/-.** P/P. 4/6.

MUIRHEAD PRECISION STUD SWITCHES. Brand new and boxed. 4 banks, each bank 24 position. Heavy duty contacts. Only **17/6** each. P/P. 1/6.

L.T. TRANSFORMER BARGAINS. Type 1. 200/250 volt input. Output tapped 3, 6, 9, 12, 24 or 36 volts 5 amps. **35/-** each. P/P 3/-. Type 2. 200/250 volt input. Output 12 volts 5 amps. **12/6** each. P/P. 2/-.

D.C./A.C. ROTARY CONVERTOR. Input 24 volts D.C. Output 230 volts 50 cycles A.C., 100 watts. Unused. **92/6** each. P/P. 5/-.

6-VOLT VIBRATOR POWER PACKS. Output 120 volts 30 ma. Fully smoothed, uses standard 4-pin Mallory vibrator. New and boxed. **12/6** each. P/P. 2/6.

CRYSTAL MICROPHONE INSERTS. Sensitive, ideal for amplifiers, tape recorders, etc., **4/6** each. P/P. 6d.

POST OFFICE 20-WAY TELEPHONE JACK BOARDS. Standard fitting, brand new and boxed, **15/-** each. P/P. 1/6.

12-VOLT MOBILE AMPLIFIERS. Ex Admiralty. Separate mic. or gram inputs. Output 10 watts, matched to 3, 15 or 600 ohms. Supplied in good working order. **£8/19/6** each. P/P. 5/-.

HEAVY DUTY SLIDER RESISTANCES. 1 ohm 12 amp. **6/6** each. P/P. 1/-.

300FT. COPPER AERIAL WIRE. Ex U.S.A. Brand new. **3/6** reel. P/P. 1/-.

AMERICAN GEARED MOTORS. American 24 volt D.C. motor with built-in precision gearbox giving twin outputs 20 r.p.m. and 6 r.p.m. Will also operate on 12 v. giving reduced outputs. Size 7in. × 1¾in. Shaft dia. ¼in. Supplied brand new only. P/P. 3/-. **19/6** each.

SMOOTHING CHOKE BARGAINS. 10H. 60 ma., 4/6; 15H. 60 ma., 5/6; 8H. 100 ma., 8/6; 9H. 100 ma., 7/6; 10H. 100 ma., 8/6; 5H. 200 ma., 5/6; 20H. 120 ma., 10/6; 50H. 120 ma., 15/6; swinging choke 3.6-4.2H. 250 ma., **10/6.** P/P. 1/- to 2/6.

MARCONI SIGNAL GENERATOR TF144G Frequency coverage 85 kc/s-25 mc/s., supplied reconditioned and guaranteed, **£65** each, P/P. £1.

EX NAVY SOUND-POWERED TELEPHONES. This type requires no batteries to operate and can be fitted in moments to give complete inter-communication between two points. Hand generator calling. Only **45/-** each. P/P. 4/6.

RCA. OUTPUT TRANSFORMERS. Completely potted. Centre-tapped primary, 8,000 ohms. Secondary tapped 3, 7.5, 15 or 600 ohms. Separate feedback winding. 15 watts rating. Suitable for 6L6, EL84, etc., unused, **27/6** each. P/P. 2/-.

SPECIAL OFFER

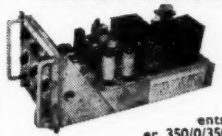
OF ALKALINE NIFE ACCUMULATORS. Bank of 10 cells giving 12 volts 45 A.H. Unused in wooden crates. Only **£5/10/-** each. Also available, banks of 9 cells. **£4/19/6** each. P/P. 7/6 both types.

RCA. ET.4336 PLATE TRANSFORMERS. Special release, brand new in original maker's transit cases. Primary tapped 200 to 250 volts 50 cycles. Secondary 2,000/0/2,000 volts 400 ma., tapped 1,500/0/1,500 volts. Price **£12/10/-** each. P/P. £1.

EDDYSTONE MAINS POWER PACKS S.44IB. Supplied brand new and unused. Input 200/250 volts. Output 300 volts 200 ma. and 12 volts 3 amps. Double choke and condenser smoothed, 5U4 rectifier. Housed in grey metal case, fully fused, indicator, etc. Only **49/6** each. P/P. 6/-.

A.C. MAINS VOLTAGE REGULATOR TRANSFORMERS. Input 230 volts. Output variable from 185 to 250 volts at a max. rating of 24 amps. Ideal for laboratory use, etc., supplied as new. **£15** each. P/P. 10/-.

MODULATOR 67



A wonderful complete A.C. mains power pack containing the following components. Transformer 350/0/350 v. 200 ma. 6.3 v. 6 a. 5 v. 3 a. Input 230 v. 200 ma., choke, 5Z4 rectifier. Paper and electrolytic smoothing condensers. 11 other useful valves. Hundreds of components including switches, pots, condensers, resistors, etc. Supplied brand new with covers.

SPECIAL REDUCED PRICE 39/6 each

P/P. 7/6

HEAVY DUTY MAINS ISOLATING TRANSFORMERS. Specifications: Primary 230 volts 3 amps. Secondary 230 volts 3 amps (service rating, OK 5 amps.). Ideal for laboratory or workshop use. Supplied brand new in original transit cases. **£6/10/-** each. P/P. 10/-.

GOODMAN'S 12in. HEAVY-DUTY LOUDSPEAKERS. 15 ohm speech coil. 15 watts rating. Brand new in sealed cartons. **£5/15/-** each. P/P. 5/-.

HEAVY-DUTY AUTO TRANSFORMERS. Ex Admiralty, made to highest specification. Tapped from 70 volts to 230 volts in 10 volt steps at 600 watts. OK for 750 watts. Brand new, only **69/6** each.

EDDYSTONE MAINS POWER PACKS

Supplied brand new and unused. Mains input 200/250 volts. Output 175 volts 60 ma. and 12 v. 2.5 a. Double choke and condenser smoothed. 5Z4 rectifier. Housed in grey metal case. Only **32/6** each. P/P. 3/6.

DYNAMO EXPLODER UNITS Used for detonating explosive charges. Operation is by hand generator, giving 1,800 volts across output terminals. Ideal also as photo flash. Brand new, only **29/6** each. P/P. 3/-.

POST OFFICE JUMPER LEADS. Fitted with 2 standard jack plugs, brand new, 3/-. P/P. 6d. Panel jacks to fit **9d.**

AMERICAN ROTARY TRANSFORMER Models available for either 6 or 12 volt D.C. input Output 250 volts 80ma. Ideal for car radios or razors etc., new and unused **22/6** each. P/P 3/-.

AMERICAN SUPER LIGHTWEIGHT HEADPHONES. Res. 50 ohms. Fitted with rubber earmoulds to fit inside the ear. Extremely good quality, ideal for communication receivers, etc. New and boxed. **15/-** pair. P/P. 1/-.

12-VOLT MIDGET ROTARY TRANSFORMERS. Type H.T.11, size 4½×2¾in. Output 310/360 volts 30 ma. New and boxed. **22/6.** P/P. 1/6.

BARGAIN GRAM MOTORS. Garrard centre-drive motors complete with turntables. 200/250 volt A.C. Adjustable mechanically from 0 to 45 r.p.m. Only **22/6** each. P/P. 3/-.

"C" CORE TRANSFORMERS

Special offer, all brand new and boxed. All types have 230 volt 50 cycle input. Type 1. 510/0/510 v. 300 ma. 375/0/375 v. 100 ma. 6.3 v. 9 a. 2×6.3 v. 2 a. 2×6.3 v. 1 a. 6.3 v. 1.5 a. 6.3 v. .5 a. 5 v. 3 a., **82/6.** P/P. 5/-. Type 2. 450/0/450 v. 250 ma. 2×6.3 v. 5 a. 2×6.3 v. 1 a. 5 v. 4 a., **65/-.** P/P. 4/6. Type 3. 450/0/450 v. 220 ma. 6.3 v. 6 a. 6.3 v. 3 a. 5 v. 3 a., **59/6.** P/P. 4/-. Type 4. 350/0/350 v. 400 ma. 25 v. 1 a. 21 v. .5 a. 6.3 v. 5 a. 6.3 v. 1 a. 5 v. 4 a., **65/-.** P/P. 4/6. Type 5. 360/0/360 v. 200 ma. 360/0/360 v. 65 ma. 6.3 v. CT 5 a. 6.3 v. CT 2 a. 6.3 v. 5 a. 5 v. 4 a. 5 v. 3 a., **65/-.** P/P. 4/6. Type 6. 3850 v. 5 ma. 4 v. 2.5 a. 4 v. 1 a., **52/6.** P/P. 3/-. Type 7 1250/0/1250 v. 5.5 ma. 6.3 v. 1 a. 6.3 v. 1 a. 4 v. 1 a., **42/6.** P/P. 2/6. Type 8. 6.3 v. 5 a. 6.3 v. 4 a. 2×6.3 v. 3 a. 6.3 v. 2 a. 6.3 v. 1.5 a. 6.3 v. 1 a., **45/-.** P/P. 2/6. Type 9. 3×6.3 v. 3 a. 6.3 v. 1.5 a., **32/6.** P/P. 2/-.

AMERICAN AUTO TRANSFORMERS. 110/230 volts. 40 watts. Small size, fully shrouded. Ideal for instruments, shavers, etc. Brand new, boxed, **12/6** each. P/P. 1/9.

FERRANTI POTTED FILAMENT TRANSFORMERS. Hermetically sealed, ceramic terminations. All new and boxed. Type 1, 200/250 v. input. Output 6.3 v. CT. 5.6 a., tapped 5 v. 6.3 v. CT. 4.8 a. tapped 4 v. 6.3 v. CT. 1 a. tapped 4 v., **19/6** each. Type 2. Input 200/250 v. Outputs, 6.3 v. CT. 3.3 a. tapped 5 v. 6.3 v. CT.1 a. tapped 4 v. 6.3 v. CT. .9 a. 6.3 v. CT. .6 a., **15/6** each. P/P. 2/- each type.

INSTRUMENT POTENTIOMETERS. Brand new Colvern type. 100,000 ohms, 10 watts, 3½in. dia. Ideal for bridges, etc., **10/6** each. P/P. 1/-.

MIDGET RECORDER MOTORS. Size 1½×1×2½in. Operates from 4.5 to 24 v. D.C. Fitted with reduction gear. New and boxed. **12/6** each. P/P. 1/-.

CHARGING AND MODEL TRANSFORMERS

1. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 1 amp., **9/9.**
2. Pri 200/250 v. Sec. 3.5, 9 or 17 v. 2 amp., **14/3.**
3. Pri. 200/250 v. Sec. 3.5, 9 or 17 v. 4 amp., **16/6.**

Postage 1/6 all types.

L.T. METAL RECTIFIERS. Full wave and bridged. 12 v. 1 amp., 6/3; 12 v. 2 amp., 9/3; 12 v. 4 amp., 13/9; 24 v 1 amp., 12/6; 24 v. 4 amp., 22/6; 36 v. 4 amp., 27/6. P/P. 1/- all types.

TAYLOR 6in. 50 MICRO-AMP METERS Square face, flush fitting. Scaled 0-25 M/W. Brand new, boxed, **£5/19/6** each, P/P. 2/-.

MINIATURE H.T. TRANSFORMER. Input 220/240 v. Output 220 v. 25 ma. 6.3 v. 1 a., new, **10/6** each. P/P. 1/-. Midget contact rectifier to match, **7/6.**

MINIATURE SLOW MOTION DRIVES. Dia. 1¾in. 180 deg. scale calibrated 0-100. For ¼in. spindles. New and boxed **7/6** each. P/P. 1/-. Larger type available **7/6** each.

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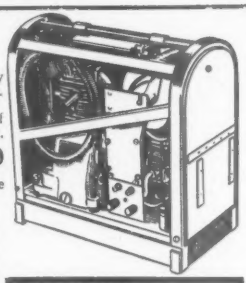
PETROL ELECTRIC CHARGING SET

12/18 volts, 80 watt. Ideal battery charging unit or for Field Days. Size 14½×7½in. Weight 46lb. Brand new, with complete set of running spares and canvas cover.

£11 10 0

Plus 10/- Packing and Carriage



ROOM THERMOSTATS

By well-known manufacturer. Made to control loads up to 15 amps, 200-250 volts A.C. Temperature range 50-80 deg. F. Brand new. Cream finish with installation instructions **15s. 0d.**

Plus 2/- Postage and Packing

CHARGING RECTIFIERS

12 volt 4 amp Full Wave. **12s. 0d.**

Plus 1/6 Postage and Packing

BINOCULAR TYPE INFRA RED VIEWING EQUIPMENT

Complete with EHT supply operating from 12 volt D.C. Originally designed for night driving. Complete with cleaning fluids and canvas carrying cases. Packed in transit cases..... **£3 10 0** *Carriage 7/6*

70 cm. TEST GEAR

Owing to a recent LARGE release of TS.184 A/AP Test Sets we are now able to offer this precision equipment at the amazingly low price of 57/6 *Carriage paid*

Supplied new in original transit case complete with 24-page handbook containing simple conversion for Signal Generator, circuit diagrams and illustrations.

Resonant cavity wavemeter, calibrated 400-430 Mc/s. Tuning stops adjustable to any 30 Mc/s. band within 400-470 Mc/s. coverage. Calibrated scale rack and pinion drive piston input attenuator—and alternative fixed coupling loop input provides facilities for use as a signal generator. Plug-in "Telescopic probe antenna" 6J6 Detector and Monitor amplifier, 2-600 ohm phone jacks for modulated signals. Panel output terminals for metering 6J6 output current. Power required 6 volts at 300 m/A and 30 volts at 0.5 m/A.

SIGNAL GENERATOR AND WAVEMETER Type W.1649

Frequency of signal generator: 140 to 240 Mc/s. Accuracy ± 0.5 Mc/s. Frequency of Heterodyne Wavemeter: 155 to 255 Mc/s. Accuracy ±.02 Mc/s. Containing VR.135 and 4-VR.91 5 meg. crystal. Retractable aerial. Power requirements: 6.3 volts and 120 volts. Unit housed in copper lined wooden case. Size: 15½in. × 13in. × 14½in. In good used condition. **£2/10/-.**

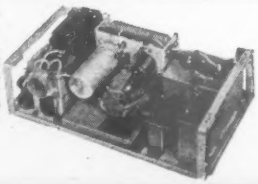
Plus 10/- Packing and Carriage

RADIO ALTIMETER

.5mA panel mounting meter, 3in. dia., 8in. circular scale. Large magnet. Scale easily removable leaving finished faceplate for recalibration. Basis for sensitive portable multimeter. Brand New. Boxed. *Post Free* **7s. 6d.**

TYPE 173 POWER UNIT

24 volt D.C. Input, 120V, 60 mA Output. Containing Vibrator Transformer, 12 Volt Vibrator. Two 120 Volt Selenium Rectifiers, Chokes and Condensers. Size 10½in. × 6in. × 3in.



Price **10s.** post paid.

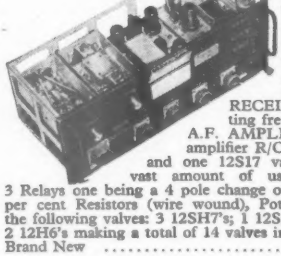
F.M. RECEIVER ARR.3

Frequency: 60 Mc/s. Requires only a simple conversion to B.B.C. F.M. Transmissions.
Valve Line-up: 1st RF 12SG7. 2nd RF 12SG7. Mixer 12SG7. Osc. 12SG7. 1st IF Amp 12SG7 2nd IF Amp 12SG7. Limiter 12SG7. Det 12H6. 1st AF Amp. 12SQ7. O/P 12A6. 2—12SH7's AFC. Magic Eye 12U5G. **£6 0 0**

Circuit diagram supplied

Plus 7/6 Packing and Carriage.

AN/APN.1 TRANSMITTER/RECEIVER



Frequency approx. 400-485 Mc/s.
R.F. TRANSMITTER. Operating 67.42 cm. (445 Mc/s). with a band width of 40 Mc/s. Modulation of its carrier is by means of a moving coil Transducer.
Two 955 (VT.121) valves; quickly converted for Radio control and 70 cm.
RECEIVER. Tuned to the Transmitting frequency. Two 9004 valves.
A.F. AMPLIFIER. An audio frequency amplifier R/C coupled, using two 12SH7's and one 12S17 valves. The AN/APN.1 has a vast amount of useful components including: 3 Relays one being a 4 pole change over type 3 off 1 megohm. 1 per cent Resistors (wire wound), Potentiometers, dynamotor, and the following valves: 3 12SH7's; 1 12SJ7; 1 VR, 150/30 (OD.5) and 2 12H6's making a total of 14 valves in all. **£1 10 0**
Brand New .....

Plus 7/6 Packing and Carriage

'S' BAND PRECISION WAVEMETER

2900 to 3150 Mc/s. TEST SET 288 A.M. Ref. 10SB/6161

Comprising exceptionally rugged silver-plated Wavemeter Type 1665, resiliently mounted and directly tuned by 7½in. dia. calibrated micrometer with 6½in. thimble scale. Temperature correction for micrometer attached. Resonance indicated on 100 microamp meter. Equally suitable for laboratory using milliwatt powers or, with loose coupling, for high powers. UR21 connecting cable and coupling probe supplied. Brand new in robust moisture-proof case with jacking-off screws and tool..... **£15 0 0**

Plus £1 Packing and Carriage

SIGNAL GENERATOR. 600—1200 Mc/s

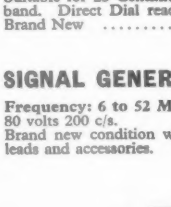
Test Set 281, Ref. 10SB/6152. Operates from 230 volt 50 cycle Mains. In case 14in. × 14in. × 12in. Fitted 11in. Dia Parabolic Aerial and Perspex Radome. 2.CV.90 (Mazda Osram E.1368). Oscillator in Precision Cavity. Modulator and 6X5 Rectifier.
Suitable for 23 Centimetres and Latest B.B.C. Television 654 Mc/s band. Direct Dial reading Wide Band.
Brand New **£22 10 0**

Carriage Paid

SIGNAL GENERATOR TYPE 52A

Frequency: 6 to 52 Mc/s. Internal Power Pack 230 volt 50 c/s. or 80 volts 200 c/s.
Brand new condition with 4 calibration charts in transit case, with leads and accessories. **£10 0 0**

Plus 10/- Packing and Carriage



MULTI-RANGE TEST METER

Ranges: 0-1.5 and 0-3 volts; 0-60 milliamps; 0-500 and 0-5,000 ohms. Ranges can be easily extended. Readings are obtained quickly and easily on a very open scale. Size: 2½×3½×3½in. Brand new with carrying strap **8s. 6d.**

Plus 1/6 Post and Packing

MAINS CHANGING TRANSFORMER

(Admiralty Pattern) 230/100-110-130V. Separate primary and secondary with earthed screen winding between. Totally enclosed in 7in. × 6in. × 8in. black steel case with detachable lid exposing terminal block and tapping link. Secondary very conservatively rated at 0.44 amps. (core size 3 sq. in.). Tested to 2,000V. Weight 19lb.....Each **£1 0 0**

Including Postage and Packing

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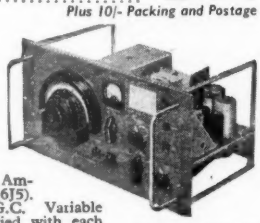
TRANSMITTER/RECEIVER No. 19. Mk. II

Frequency coverage 2 to 8 Mc/s. for R/T. MCW. CW. Superhet Receiver 465 kc/s. I.F.'s BFO, etc. Receiver line-up: 6K7 RF; 6K8 Mixer; Two 6K7 I.F.'s; 6B8 Det. Transmitter line-up: 6K8 Mixer; VFO EF50 buffer; ADC EB34; 807 P/A. This unit incorporates a TX/RX 229 at 241 Mc/s. with a local range of 1 mile. Valve line-up: CV6. Two 6K7's and 6V6. Also intercom set two valve AF amplifier 6K7 and 6V6.
As new condition and American manufacture. Fully valved **£3 5 0**
Plus 10/- Packing and Postage

RECEIVER TYPE R.1132A



Frequency 100-120 Mc/s. 11 Valve Superhet. Valve line-up: RF. Amp. VR.65; Frequency Changer VR.65; Local Oscillator VR.66; Stabilizer VS.70; I.F. Amplifiers V.R. 53's; B.F.O. V.R.53; Detector V.R.54; A.F. Amplifier V.R.57; Output V.R.37 (6J5). Switchable A.V.C. and A.G.C. Variable B.F.O. Circuit diagram supplied with each unit. Easily converted to receive Wrotham band with no alteration to wiring. Conversion instructions available to each purchaser. Size 19in. × 10in. × 10in. **£3 7 6**
Standard Rack Mounting.....
Packing and Carriage 10/- extra

INFRA RED MONOCULAR

Sealed unit incorporating push-button operated zamboni pile. Focussing eyepiece. Brand new in stout hide (binocular type) case. ..... **£1. 0. 0.**
Carriage Paid

THROAT MICROPHONES T.30.

Including socket ..... **3s. 0d.**
Post Paid

CRYSTAL MIKE INSERTS Each ..... **4s. 6d.**
Post Paid

ELECTRIC TIME SWITCH

Beautifully made clockwork mechanism automatically wound by 6 volt Solenoid. The time switch can be set for any period between 30 minutes and 44 days. This robust unit is housed in strong Bakelite case 4in. in diameter. **12s. 6d.**
Post Paid

GYRO UNIT AND INVERTER

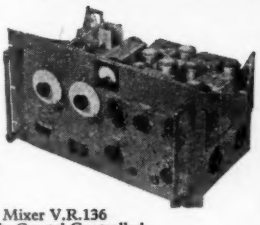
Inverter: 12 volt d.c. input 3-phase 190 cycle output. (These inverters can be used successfully as 12 volt d.c. Motors for Models.)
Gyro Unit: Operates on 3-phase output from Inverter. Peak speed 11,400 r.p.m. Caged. Precision made equipment.
These units are ideal for experimenting and demonstration purposes. Size: Inverter 4 × 4 × 3in.; Gyro 4in. dia. incl. cage.
per pair **12s. 6d.**
Plus 3/- Post and Packing

SET OF 4 AIRCRAFT INSTRUMENTS

1—Speed of sound (MACH) meter; 1—Rate of climb; 1—Air speed indicator; 1—Altimeter.
The lot ..... **10s. 0d.**
Post Paid

I.N. 21a SILICON CRYSTALS **1s. 6d.**
Post Paid

RECEIVER TYPE R.1392



Frequency 95-150 Mc/s (2-3 Metres). Air Tested 15 Valve Superhet. Valve Line-up: 1st and 2nd R.F. Amp. VR.136 (EF54); 1st Local. Oscillator V.R.65 (SP61); 2 Oscillator Multipliers V.R.136 (EF54); 3 I.F. Amp. V.R.53 (EF39); AGC. 6Q.7. Output 6J5; Muting V.R.92 (EA.50); Noise Limiter V.R.92 (EA.50); B.F.O. 6J7; Mixer V.R.136 (EF.54); De Mod. 6Q7. Normally Crystal Controlled but can be tuned over 95 to 150 Mc/s. Power supply required: 240-250 volts at 80 mA. 6.3 volts at 4 amps. Size 19 × 10in. × 10in. Standard Rack Mounting. **£6 19 6**
Complete with valves and circuit diagram.....
Packing and Carriage 10/- extra

DESYNN TYPE ANTENNA or Beam position indication system

This comprises a transmitter unit and Indicator which will operate on 12 or 24 volts D.C. and will indicate with instantaneous and smooth pointer movement. The Transmitter is a specially designed potentiometer and will operate the receiver on a simple three-wire system and the receiver in this instance is calibrated in gallons but dial could be easily altered to indicate a 360 deg. sweep. Transmitter and receiver with full instructions..... **12s. 6d.**
Plus 2/- Packing and Carriage

TANNOY SPEAKERS

External 8 watt unit 7½ ohms impedance complete with matching transformer. New **£1 0 0**
Plus 3/6 Postage

HIGH RESISTANCE EARPHONES

2,000 ohm single units..... **3s. 6d.**
Plus 1/- Postage and Packing

BALANCED ARMATURE EARPHONES

High Resistance (Complete Head Set) ..... *Post Paid* **20s. 0d.**

AN/APN.1 TRANSDUCER

This Unit consists of Magnet and Coil which is attached to an aluminium diaphragm suspended freely and perforated to prevent air damping. Mounted on a Ceramic cover which sits over the diaphragm is a form of 2-gang capacitor which has a swing from 10-50 pF.
The above unit is used as part of Wobbulator described on page 252 of the June, 1956, "Wireless World." **7s. 6d.**
Post Paid

ASTRO COMPASSES

New and Boxed £1, plus 3/- postage and packing.

I.F. AMPLIFIER UNIT

460 kc/s. with IT4. Brand New and Boxed Fully Screened in plug-in Box. Size 2½in. × 1in. × 4½in. With circuit. **10s. 0d.**
Plus 1/- Postage and Packing

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ALPHA VALVES

Guaranteed All Tested Before Dispatch.

AC6PEN	6/6	PCL82	14/6	1S4	10/6
AC/TH1	34/9	PCL83	14/6	1S5	7/6
ATP4	3/6	PL38	27/10	1T4	7/6
AZ31	17/5	PL81	15/-	2C26	2/6
CBL31	24/4	PL83	9/6	2X2	4/6
CCH35	24/4	PL83	11/6	3A4	7/-
CL33	20/2	PP225	3/11	3D6	5/-
CY31	17/5	PX25	12/6	3Q4	9/-
DAF96	10/6	PY80	9/-	3Q5GT	9/6
DF96	10/6	PY81	10/-	3S4	8/-
DK96	10/6	PY82	8/6	3V4	9/-
DL96	10/6	PY83	10/-	4D1	3/-
DM70	8/6	PZ30	20/11	5B4GY	9/6
EA50	1/6	PEN4DD	27/10	5U4G	8/-
EABC80	10/-	PEN25	5/-	5Y3G	8/-
EAC91	7/6	PEN44	27/10	5Y3GT	8/-
EAF42	10/6	PEN46	7/-	5Z4G	10/-
EB34	2/-	PEN220A	4/-	6A7	13/-
EB41	9/-	PENA4 A	15/-	6A8G	10/-
EBC33	7/6	QP21	7/6	6AG7	6/6
EBC41	10/6	R16	27/10	6AL5	6/6
EBF80	10/6	SP41	3/-	6AM6	9/-
EBF89	18/1	SP61	3/-	6AQ5	7/6
EBL21	24/4	SP220	3/11	6AT6	6/6
EBL31	24/4	T41	24/4	6QU6	10/6
EC52	6/-	TH2	9/-	6B4	5/-
ECC40	12/6	TH30C	8/-	6B8G	4/-
ECC84	10/3	TH41	12/6	6BA6	7/6
ECC85	9/6	U10	10/6	6BE6	3/-
ECF80	12/6	TP25	27/10	6BG6G	24/4
ECF82	12/6	U22	8/-	6BH6	16/-
ECH21	24/4	U24	12/6	6BJ6	9/-
ECH35	10/6	U25	13/6	6BR7	11/6
ECH42	10/-	U37	27/10	6BW6	8/6
ECH81	9/-	U45	15/-	6BW7	10/-
ECL80	10/6	U403	17/5	6C4	7/-
ECL82	13/6	U404	11/10	6C8G	6/6
EF22	8/6	U801	31/4	6C8G	5/-
EF36	6/-	UABC80	18/1	6C8G	5/-
EF37A	12/-	UAF42	10/6	6CD6G	31/4
EF39	6/6	UB41	9/6	6CH6	7/6
EF40	13/6	UBC41	10/-	6D6	5/-
EF41	9/9	UBF80	9/6	6F1	13/6
EF42	14/-	UBF89	18/1	6F6G	7/6
EF50	4/-	UCC84	20/11	6F8G	7/6
EF54	6/-	UCF80	23/-	19BG6G	24/4
EF55	10/-	UCH42	10/6	20D1	16/-
EF80	8/6	UCH81	11/6	20F2	24/4
EF85	9/-	UCL82	23/-	20P1	27/10
EF86	13/6	UCL83	25/9	20P3	20/11
EF89	10/-	UF41	10/6	20P4	20/11
EK32	8/6	UF80	19/6	20P5	20/11
EL32	5/6	UF85	12/6	25A6G	20/2
EL33	20/2	UF89	16/-	25L6GT	10/-
EL38	27/10	UL41	10/6	25Y5G	9/9
EL41	10/6	UL44	27/10	25Z5	10/-
EL42	11/6	UL46	24/4	25Z6	10/-
EL84	10/6	UL84	10/6	27SU	20/11
EM34	10/-	UU5	20/11	30F5	12/6
EM80	10/6	UU8	27/10	30FL1	12/6
EM81	11/6	UU9	8/6	30P4	15/-
EY51	12/6	UY41	8/6	35L6GT	9/6
EY86	17/6	UY85	10/-	35W4	8/6
EZ40	9/-	VP2B	8/-	35Z4GT	8/-
EZ41	10/-	VP23	6/6	35Z5GT	9/-
EZ80	8/9	VP41	8/6	42	9/-
EZ81	11/10	VR105/30	6/6	50C5	11/6
EZ90	8/-	VR116	4/-	50CD6G	31/4
E1148	3/-	VR150/30	5/-	50L6GT	8/6
GZ32	12/-	V870	3/-	75	11/6
H30	5/-	VU120A	3/6	77	7/6
HL23DD	8/6	VU39(MU12/14)		80	9/6
HL92	12/6		8/9	142BT	3/6
HN309	13/6	VU111	2/6	185BT	34/9
K40N	9/-	W77	8/6	210DDT	4/6
KF35	8/6	W729	13/6	210VPT	3/6
KK32	23/-	X65	12/6	807	6/6
KLL32	8/6	X78	22/3	954	2/-
KT24	5/-	X79	11/6	955	4/9
KT33C	10/-	Y63	9/-	956	3/6
KT36	27/10	Z309	11/6	9001	5/6
KT55	15/-	Z359	11/6	9002	5/6
KT66	15/-	Z759	11/6	9003	5/6
KTW63	7/6	1A3	3/6	9004	5/6
KTZ41	8/6	1A5GT	6/-	9006	5/6
ME21	7/6	1A7	12/6		
MH4	7/6	1C2	11/6		
MH41	7/9	1C5GT	12/6		
N37	18/1	1D5	12/6		
N78	12/6	1H5GT	10/6		
P61	3/6	1L4	6/6		
PCC84	10/-	1LD5	3/6		
PCF80	13/6	1N5	10/6		
PCF82	12/6	1R5	8/-		

6X5G	7/-
6X5GT	7/-
6/30L2	12/6
7B7	8/6
7C5	8/-
7C6	8/-
7H7	9/-
7Q7	9/-
7S7	9/6
7Y4	8/6
8D2	2/9
9D2	3/6
10F1	27/10
12A6	6/6
12AH8	11/6
12AT6	10/6
12AT7	9/-
12AU7	7/6
12AX7	8/6
12BA6	9/-
12BE6	10/-
12BH7	11/6
12C8GT	8/-
12H6GT	3/-
12J5GT	4/6
12J7GT	10/6
12K7GT	8/6
12K8GT	13/6
12Q7GT	8/6
12SC7	2/6
12SG7	7/6
12SH7	5/6
12SJ7	8/-
12SK7	6/-
12SL7	8/-
12SN7GT	17/6
12SQ7	8/6
14S7	14/6
15D2	7/9

PACKING AND POSTAGE—6d. per valve. SAME DAY SERVICE.

ISOLATION TRANSFORMERS. Mains input NR20A 2 volt, NR20B 4 volt, NR20C 6.3 v., all with 25% boost. All one price 10/6 each.

Full range of Osmor, Teletron, Wearite, Repanco Coils, Ferrite Rods, Coil Packs, etc. etc. See our catalogue for full details.

Selection of ½, ¼ and 1 watt resistors, all brand new 12/6 per 100. Maroon Twin Twisted flex 6d. yard. Morse Keys 2/- ea. 24 v. D.C. Bells 4/6 ea. Full wave rectifiers 12 v. 4 amps. 15/6 each. Pile wound chokes R.F. 1/6 each.

OUR 1957-1958 CATALOGUE IS NOW AVAILABLE TO ALL READERS OF THIS MAGAZINE. 48 PAGES OF COMPONENTS AND EQUIPMENT OF INTEREST TO ALL RADIO ENTHUSIASTS. SEND 1/- IN STAMPS FOR YOUR COPY.

LOUDSPEAKER UNITS

Make	Type	Size	Price
Elac	Square	3½in.	19/6 each
Lectrona, Plessey	Round	5in.	17/6 each
Goodmans, Plessey	Round	6½in.	18/6 each
Goodmans, R. & A.	Round	8in.	19/6 each
Plessey, R. & A., Elac	Round	10in.	25/6 each
Plessey	Round	12in.	35/- each
Elac	Elliptical	7in. × 4in.	19/6 each
Elac	Elliptical	10in. × 6in.	25/6 each

All the above are PM units with 2 to 3 ohm speech coils.

RTC 12in. heavy duty 20 watts model 15in. ohms
Speech Coil £5 5 0
5in. Mains Energised Speaker £1 0 0

SPECIAL OFFER
Just a few 8in. units by Goodmans and Lectrona fitted with standard output transformer ..... £1 1 6 each
8in. P.M. Speaker Units with Output Transformer removed from equipment. 11/6 each

6½in. Mains Energised Speaker 17 6
8in. Mains Energised Speaker £1 1 0
All have field coils of approx. 600 ohms.

MAINS TRANSFORMERS

3 Way Mounting Type.

MT1
Primary: 200-220-240 v. Secondaries: 250-0-250 v. 80 m/A 0-6.3 v. 4 amp. 0-4 v 2 amp. Both tapped at 4 v., 21/9 each.

MT2
Primary: 200-220-240 v. Secondaries: 350-0-350 v. 80 m/A 0-6.3 v. 4 amp. 0-5 v 2 amp. Both tapped at 4 v. 21/9 each.

MT3
Primary: 200-220-240 v. Secondary 30 v 2 amps. Taps at 3 v., 4 v., 6 v., 8 v., 9 v. 10 v., 15 v., 18 v., 20 v., 24 v., 21/9 each. Postage and Packing please add 2/- per transformer.

ATTRACTIVE CABINETS for 3 valve TRF kit, complete with chassis, dial, backplate, dial drum, pointer, etc. etc. 27/6. Post 3/-.

STUDIO 'S' KIT complete with Headphones, Battery, Valve, and all other parts to build this Popular Kit, 45/4. Post paid.

TELETRON COMPANION complete kit of parts for this 3 Transistor Pocket Radio. Ferrite Rod, case, etc., 89/6.

COMPLETE RANGE OF METAL RECTIFIERS. Compare the prices. RM1 4/6; RM2 5/6; RM3 7/6; RM4 16/-; RM5 16/6; 14A97 13/-; 14A86 13/6; 14A100 15/-.

LOUDSPEAKER CABINETS

This attractive walnut-finished cabinet is available for 6½in. or 8in. speaker units. Metal speaker fret, complete with back and rubber feet.
6½in. type. Measures 8½in. × 8½in. × 4½in. at base. Price 17/6 each.
8in. type. Measures 10½in. × 10½in. × 5in. at base. Price 21/6 each.
10in. type. Very similar design. Price 16/3 each. Postage any type 2/- each.

We hold large Stocks of **CONTROL KNOBS, BRASS NUTS and BOLTS, TOGGLE SWITCHES, WAVECHANGE SWITCHES, TAG BOARDS and PANELS.** All are listed in full detail in our current Catalogue. Send 1/- in stamps for your copy

CYLDON "TELETUNER"
All types available, stations of your choice. Fit this Convertor and your troubles are over, 27/7/-.
Aerials and Oscillator Coils (all channels—all frequencies), 7/6 pair.
Also available from stock, complete range of spares.

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Long necked knobs for T.V. Receivers in walnut black and cream, 1/- each.

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Dubilier kits of condensers and chokes for Interference Suppression. 1 amp. kits 5/6. 2 amp. kits 6/-; 3 amp. kits 6/6.

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A replacement guide to pick up heads, cartridges, styli. Over 193 illustrations. 5/- each.
Osmor Coils for Collaro Type Deck Transcriptor.
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Osmor Coils for the Beginners Shortwave Receiver Radio Constructor Aug. 1957.
SW Q1 31/11 Mc/s., each 6/-.
SW Q2 12/4.5 Mc/s. each, 6/-.

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Removes scratches from Radio and T.V. Cabinets in Polythene Dispenser Tubes, each 3/-.

A NEW HIGH FIDELITY AMPLIFIER. Type R.C.1. 2 stage. For use with a 3 ohm speaker, A.C. mains, 230-240 v., recommended for use with record players, £3/19/6. Post 3/6.

CONTROL KNOBS. Mains on/off and Tone Volume. Complete with 2 valves ready to operate, £3/19/6 each. Post 3/-.

NYLON DRIVE CORD. Non stretch, 6d. per yard.

HEAD AND BREAST SETS. A pair of low resistance headphones 120 ohms resistance. A breast microphone with straps, etc. Packed in a strong wooden box, 10/6 each. Post 3/-.

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W.B. "STENTORIAN" HIGH FIDELITY UNITS. Model H.F.1012. 10in. die-cast unit incorporating 12,000 gauss magnet. Handling capacity 10 watts. Frequency response, 30 c.p.s.—14,000 c.p.s. Bass resonance, 35 c.p.s., £4/19/9.

MODELS H.F. 810 and H.F.812. 8in. unit incorporating 10,000 gauss magnet. Handling capacity, 5 watts. Frequency response 50 c.p.s.—12,000 c.p.s. Bass resonance, 65 c.p.s. Steel chassis, £3/2/-. Die-cast chassis (12,000 gauss), £4/3/6.

PAPER BASE RECORDING TAPE. 1,200 ft reel 12/6.

TERMS: Cash with order or C.O.D. Postage and Packing charges extra, as follows: Orders value 10/- add 1/-; 20/- add 1/6; 40/- add 2/-; £5 add 3/- unless otherwise stated. Minimum C.O.D. fee and postage 3/-.
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ALPHA RADIO SUPPLY CO.
103, LEEDS TERRACE, WINTOUN STREET, LEEDS, 7.

HEADPHONES—MICROPHONES

EX-GOVERNMENT HEADPHONES AND MICROPHONES

CLR low resistance type 120 ohms ..... 7/6 pair
Throat Microphones, American surplus. Complete with strap, lead and plug type T30B ..... 3/- set
High Resistance Phones, 4,000 ohms .... 13/6 pair
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Suitable for audio work yellow and green spot, ea. 10/-
red spot, ea. 10/-
A.F. for use up to 1.6 mc/s. white spot ea. 15/-
R.F. for use up to 1.5 mc/s. to 8 mc/s. yellow and red spot, ea. 21/-

JB gang condensers for transistor working "0" gang 1 or 2 gang 365 PF swing, aluminium vanes, steel chassis.
1 gang 7/6 each; 2 gang 11/6 each. JB "00" twin gang condenser 208 PF front section 17/6; PF rear section price 9/6 each.

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200 v. Input 2 volt .5 amp. 5/-
200 v. Input 2 volt 3.0 amp. 8/3
200 v. Input 4 volt 1.5 amp. 5/6
200 v. Input 4 volt 3.0 amp. 10/-
200 v. Input 5 volt 2.0 amp. 10/-
200 v. Input 6.3 volt .5 amp. 5/6
200 v. Input 6.3 volt 1.5 amp. 6/9
200 v. Input 6.3 volt 3.0 amp. 10/-
200 v. Input 12 volt .75 amp. 5/9

METERS

Instrument Meter Moving Coil, ex-Ministry 0-3 kV. Round Panel mounting. Brand new 7/6 each.
Instrument Meter 0-100 m/A. Square type. Panel Mounting. Ex-R.A.F. Equipment 7/6 each.
2 Range Pocket Voltmeter. Ex-Ministry Brand New. 0-15 volts, 0-250 volts, moving coil 345 ohms per volt, complete with leads 16/- each.

CO-AXIAL CABLE Solid 75/80 ohms, 6d. yd.

CO-AXIAL CABLE Semi Airspaced 5/870 ohms, 9d. yard.

RIBBON FEEDER 300 ohms 6d. yard.

APEX CROSSOVER BOX. Shrouded 7/6 each

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MINIATURE I.F. TRANSFORMERS 465 Kcs., 8/- pair.

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Full range of **CARBON CONTROLS,** Med spindle length, all values, 1/3 each.

COLLARO STUDIO "O" CARTRIDGE. 22/6 each.

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STENTORIAN LOUDSPEAKERS. New Miniature Models for use with Transistor Amplifiers, etc., etc. 8.1.75. Diameter 1¾in. Total depth 1in. 3 ohms impedance 26/9 each.
8—2 x 3 Elliptical Speaker. Size 3⅛in. x 1 9/32in. Depth 1¾in. 32/- each.

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TERMINAL BLOCK. Ref. No. 5X/2234 10-way. 6 yards Top Quality Maroon Flex, 2in. core twisted with 2in. pin plug, 2/9.

MARCONI DROPPER, resistance 1,000 ohms, 3 voltage taps 195/215, 216/235 236/255, 1/- each.

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6 x 4 x 2½in.	4/6 each
8 x 6 x 2½in.	6/3 each
10 x 7 x 2½in.	7/3 each
12 x 3 x 2½in.	5/9 each
12 x 5 x 2½in.	6/9 each
12 x 8 x 2½in.	8/6 each
14 x 3 x 2½in.	6/- each
14 x 9 x 2½in.	12/- each
16 x 6 x 2½in.	8/6 each
16 x 10 x 2½in.	14/- each

All are four-sided—ideal for radio receivers—amplifiers—power packs, etc.

THE NEW APEX MARK II BAND III CONVERTER. ★ B.B.C. or Commercial Programmes at the touch of a switch. ★ Built in power supply for 200/250 v. A.C. ★ Variable fine tuner and gain control. Separate mains on/off switch. ★ Robust construction for mounting on top or side of cabinet. ★ Size only 5½ x 5½ x 2½in. Retail price £5/15/- complete.

PRE-SET CONTROLS. Available wire wound 1K and 10K ohms, 2K ohms, 30K ohms. Available carbon track 50K, 100K, ½ Meg., 1 Meg., 2 Meg., 20K ohms, ¼ Meg. ohms. Various makes and types. 150K ohms. All one price. 1/9 each.

TINNED COPPER WIRE—All 4 oz. Reels.

16 S.W.G. ..	2/6	24 S.W.G. ..	3/-
18 S.W.G. ..	2/7	26 S.W.G. ..	3/3
20 S.W.G. ..	2/9	28 S.W.G. ..	3/5
22 S.W.G. ..	2/10	30 S.W.G. ..	3/9

ENAMELLED COPPER WIRE—All 4 oz. Reels.

18 S.W.G. ..	2/6	30 S.W.G. ..	3/3
20 S.W.G. ..	2/8	32 S.W.G. ..	3/7
22 S.W.G. ..	2/9	34 S.W.G. ..	3/9
24 S.W.G. ..	2/11	36 S.W.G. ..	3/11
26 S.W.G. ..	3/-	38 S.W.G. ..	4/3
28 S.W.G. ..	3/1	40 S.W.G. ..	4/7

MIDGET BATTERY ELIMINATOR. Actually smaller than the H.T. Battery alone. Complete eliminator. No batteries needed at all. Mains Switch included in lead. Transformer double insulated. L.T. supply stabilised. It is most important that the unit should be used only with LOW CONSUMPTION receivers. (Valves DK96, DL96, etc.) Specification: Mains input 220/240 v. 50 c.p.s. A.C. H.T. Output 85 v. 10 m/a. L.T. output 1.3 v. 122 m/a. Transformer double insulated. Metal case finished "Hammertone" enamel. Supplied complete with mains on/off switch. Price £2/12/6.

"NORMAN" SILICONE COATED WIRE WOUND RESISTORS. Tolerance plus or minus 10%. Each resistor clearly marked with resistance value and wattage. Available in the following values: 24, 50, 68, 100, 150, 200, 250, 350, 500, 680, 1,000, 1,500, 2,000, 2,500, 3,500, 5,000, 6,800, 10,000. Also 220 ohms. 5 watt size 1 x ½in. with 1½in. wires, 1/-. 10 watt size 1½ x ½in. with 1½in. wires, 1/3. 15 watt size 1½ x ½in. with 1½in. wires, 1/9.

COIL FORMERS. Alladin Coil Formers, ½in., complete with iron dust cores, 8d. each. Alladin Coil Formers, ½in., complete with iron dust cores. 7d. each. Ceramic Coil Formers, ½in. dia., 1in. long, 4 ribs, 4d. each. Paxolin Coil Formers, ½in. dia., 2½in. long. Removed from R.A.F. equipment and are in some cases complete with trimmers, 3d. each. Spare Iron Dust Cores, for ½in. and ¼in. formers, 3d. each.

MAINS DROPPING RESISTORS. Norman Silicone coated, .1 amp., 2,000 ohms, 4/6 each. Norman Silicone Coated, .15 amp., 1,500 ohms, 4/6 each. Norman Silicone coated, .2 amp., 1,000 ohms, 4/6 each. Norman Silicone coated, .3 amp., 1,000 ohms, 4/6 each. Testgear Cat. No. 1,084A, .3 amp., 650 ohms, 4/6 each. Testgear, Cat. No. 1084B, .2 amp., 800 ohms, 4/6 each.

RECORD PLAYER UNITS

B-S-R. MONARCH

Four speed automatic record change unit. Plays 7in., 10in. and 12in. records automatically with "MAGIDISK" Selector Turn-over Pick-up. Unit plate 12½ x 10½in. £8/15/-.

COLLARO

Model 3/544. Three speed single player. Automatic stop, fitted with "Studio T" Pick-up. Cream finish £6/19/6. Carriage on above units 4/6.

COLLARO

Four speed automatic record change unit. A fully mixing automatic changer with many advanced features. Unit plate 12in. x 13¼in. £8/15/-.

SPECIAL PURCHASE

Sin. P.M. Speaker Units with Output Transformer removed from equipment. 11/6 each.

A NEW and UP-TO-DATE T.R.F. KIT
★ BRAND NEW COMPONENTS
★ 3 VALVES—6K7, 6J7, 6V6
★ CONTACT COOLED RECTIFIER.
★ PM SPEAKER.
★ AC MAINS FULLY ISOLATED.

Circuit Diagram and Full Shopping List, 1/-. Complete Kit down to last nut and bolt, £5/10/- each. Carriage and packing 3/-.

LATEST ADDITIONS TO OUR RANGE OF CONTROL KNOBS

Pekalit Type 4000. Brown with gilded centre plate, dia. 1 7/8in... 1/6 each
Pekalit Type 4010. Brown or cream with gilded centre plate, dia. 1¼in. ..... 1/6 each
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KNOBS—BAKELITE

Large Purchase—Good Quality
Type JK1. Cream, 1¼in. diameter, spring fixing, fluted grip.
Type JK2. Brown, 1¼in. diameter, spring fixing, fluted grip.
Type JK3. Brown, 1¼in. diameter, spring fixing, plain grip. (This one has white ring on knob face).
All have a small finger flange to avoid marking cabinets.
★ OFFERED AT A FRACTION OF ORIGINAL COST ★
Price 6d. each—5/- doz. any types.
1¼ Knobs (brown), fluted grip.
Grub screw fixing ..... 6d. each

THE "OSMOR" JIFFY PUNCH

	Hole Size	Retail Price Complete
TYPE 1	¼in.	6/6
TYPE 2	⅜in.	7/6
TYPE 3	½in.	8/9

THE "OSMOR" CHASSIS CUTTER

	Hole Size	Retail Price Complete
TYPE 1	1in. x 1¼in.	19/6
TYPE 2	⅜in. x 1¼in.	18/9
TYPE 3	⅜in. x 1¼in.	22/6
TYPE 4	1¼in. x 2in.	31/6

Postage and packing 1/-. Any type.
TOMMY BAR3 1/3 each.
Allen Key for Type 2 only 2/6.
For B7G and Octal No. 2. For B9A and B8A No. 3.

BIB. WIRE STRIPPERS AND CUTTERS The new three-in-one tool which electricians, radio and television engineers and handymen have always wanted. Strips insulation without "nicking" wire. Cuts wire without leaving rough edges. Splits extruded flex. Adjustable by a turn of a screw to most wire and cable thicknesses. Nickel plated, 3/6 each.

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With screwdriver ends, plastic body, 4/- each.

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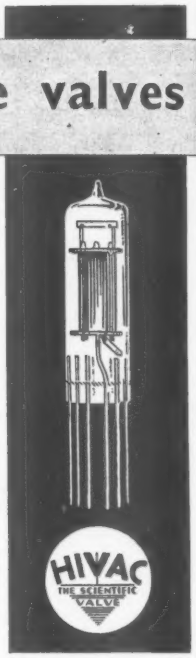

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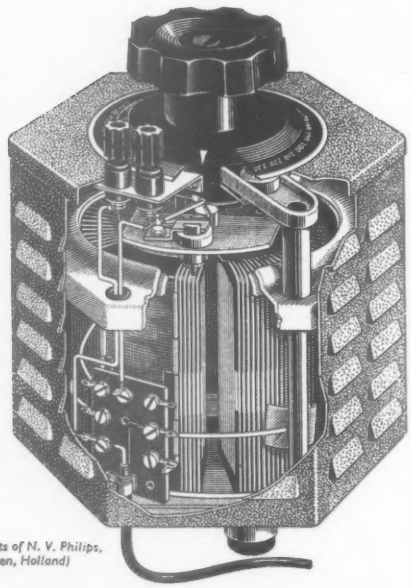

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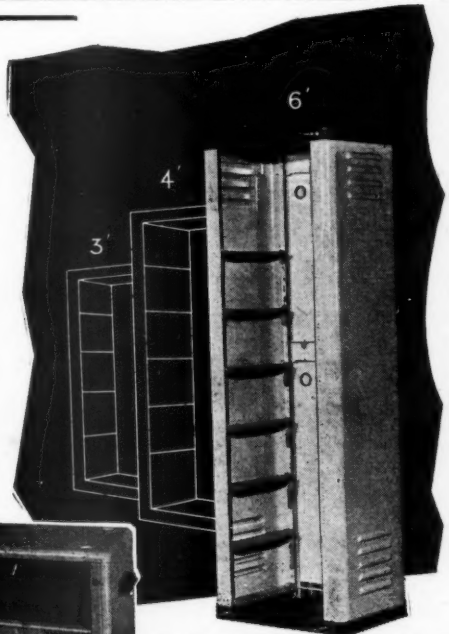

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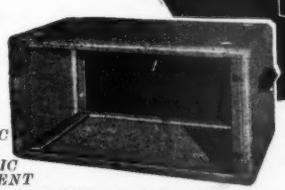

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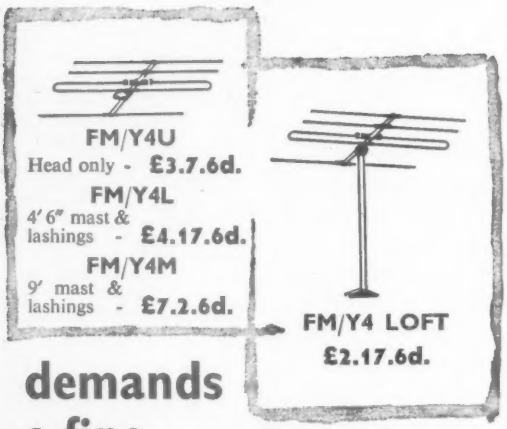

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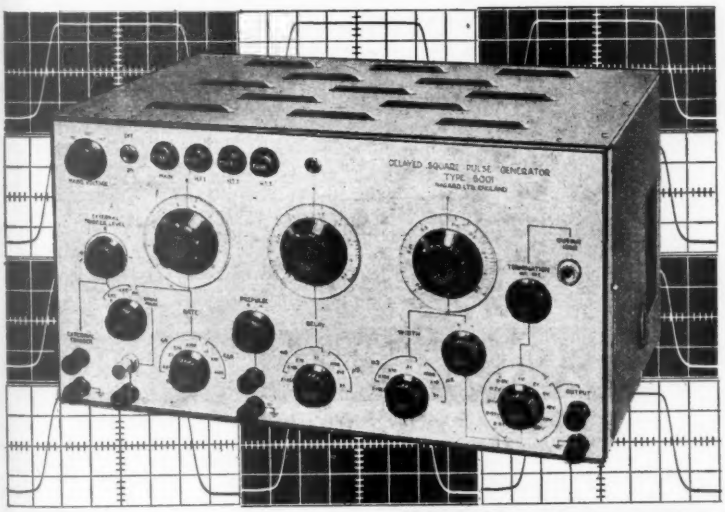

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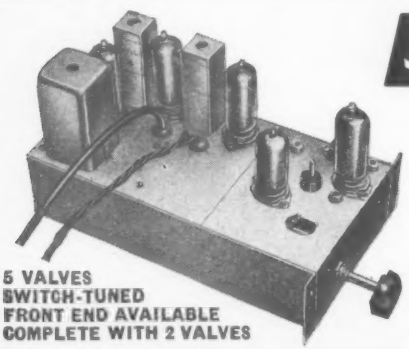

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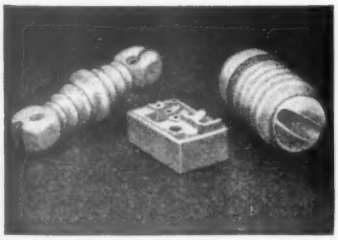

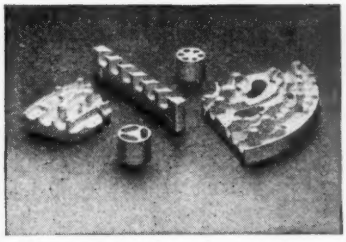

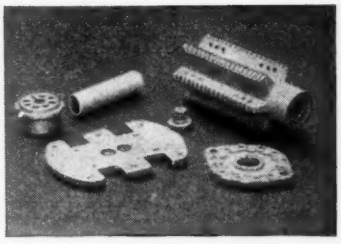

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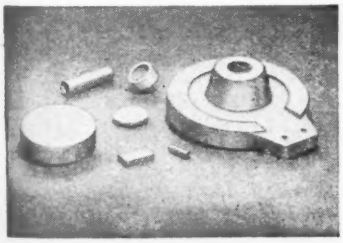

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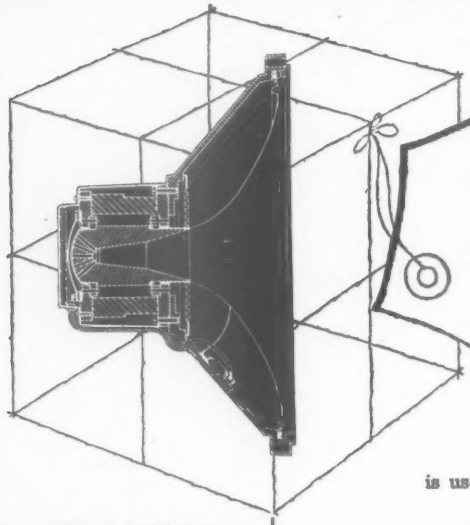

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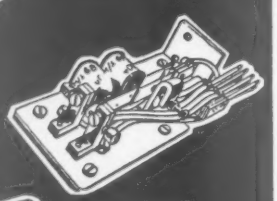

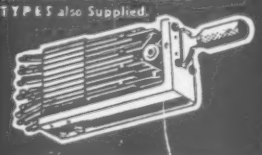

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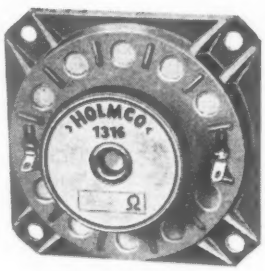

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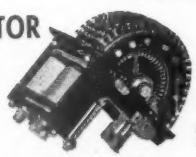

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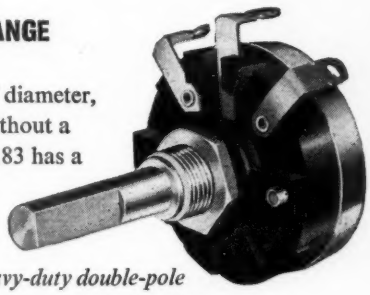

Measuring 1¼" diameter, Type 181 is without a switch. Type 183 has a double-pole Q.M.B. switch and Type 243 *a heavy-duty double-pole Q.M.B. switch specially designed for Television.* These controls are available with tappings at 33%, 50% or 60% of slider rotation, also with terminations suitable for printed circuits.

***NEW* WIRE-WOUND PRE-SET for group assembly**

Among recent additions to the EGEN range is Type 189. It has an easily replaceable wire-wound track with good heat dissipation and can be grouped with Type 166 carbon pre-set controls on a common panel.

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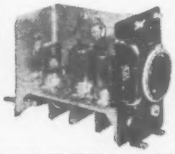


Easily the most useful units released by the Ministry. Within minutes you can extend the frequency of any receiver to cover the following:—
R.F.26 50–65 Mc/s. Variable tuning **20/-.**
R.F.24 20–30 Mc/s. switched tuning **12/6.**
R.F.25 40–50 Mc/s. switched tuning **8/6.**
R.F.24 Shop soiled, switched tuning **7/6.**
All Brand New with circuit. 3/6 postage on each.

RCAF AMPLIFIER UNIT. 12 v. input Vibrator Pack. 250 v. output OZ4. Microphone transformer into a 6K6 GT output valve with negative feed back, size 8×5½×8½in. Brand new, **30/-** each. P & P. 3/-.

WAVEMETER TYPE W1433. Frequency 154–260 mc/s., with crystal check and calibration chart. Mains 50 cycle. **50/-,** carriage 10/-.

COMMUNICATION RECEIVER RA 1B. Covers 150 kc/s.–15 mc/s. in 6 bands. 12 or 24 operation. S.A.E. for details.

INDICATOR UNIT SLC No. 5. Ideal for conversion into an Oscilloscope using a 139A or ACR 10 tube. Unit consists of 2-VR65's, 1-VR66, various resistors, condensers and pots. Size 11×6×3in. Brand new, complete with modification circuit. **20/-.** P. & P. 3/-.

PARMEKO CHOKES. 8 H. 100 mA. **7/6.** P. & P. 1/6.

AMERICAN GEARED MOTOR. 24 v. D.C. with built-in precision gear-box, No. 1 drive 24 R.P.M. No. 2 drive 6 R.P.M. On 12 v. No. 1 drive 16 R.P.M. No. 2 drive 4 R.P.M. Overall size of motor and gearbox 7½×3½×3in., weight 11b. 14 oz. Brand new. **22/-.** P. & P. 3/-.

WIRELESS SET NO. 19 MK.II Two transmitter-receivers and an intercom amplifier in one case. "A" set covers 2—8 mc/s, RT and CW, and "B" set 240 mc/s, RT. only. Complete with 15 valves and 500 Micro amp. check and Tuning Meter. Only **60/-,** plus 10/- carr.

MUIRHEAD VERNIER SLOW MOTION DRIVES. Scaled 0-180 def. Ratio 25 to 1. 3in. dia. **10/6** p.p. 1/6

WESTON 1 AMP. H.F. METERS. 2in. circular. Brand new, **5/6.** P. & P. 1/-.

DIPOLE AERIAL No. 4A. 52 feet hard drawn 7/22 copper wire with centre insulator, fitted with feeder sockets. Both ends have 3 link insulators and slotted wire adaptors. Brand new, price **9/-.** P. & P. 2/-.

500 MICROAMPS METER. 2in. circular calibrated 0–15 and 0–600 volts, resistance 500 ohms. **12/6.** P. & P. 2/6.

R.T-7/APN-1 TRANCEIVER. Brand new complete with 14 valves: 3-12SJ7, 4-12SH7, 2-12H6, 1-VR150, 2-9004, 2-955. Famous Wobulator Unit, Dynamotor, Relays 3,500 ohms and 6,500 ohms. A.F. amplifier Receiver section covers 400–450 mc/s. Transmitter sweeps 418 to 462 mc's., with manual. Only **35/-,** carriage 10/-.

RELAYS. 6,500 ohms and 3,500 ohms. **8/-** pair, post paid.

DYNAMIC SOUND POWERED HEADPHONES. Type D.L.R. 5 60 ohms. **7/6.** P. & P. 1/6.

HIGH RESISTANCE HEADPHONES. Type No. 2 4,000 ohms. Brand new **11/6** each P. & P. 1/6.

BENDIX RECEIVER MN26.C. Covering 150–1,500 kc/s. in 3 bands. Valves used 5-6K7, 2-6N7, 2-6J5, 1-6F6, 1-6L7. Complete with switching motor and dynamotor.

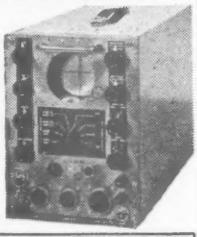
This superb unit has been modified for 12 v. operation. With circuit. Only **80/-,** carr. 8/6.

COMMUNICATION RECEIVER R1155

This magnificent receiver covers 5 ranges: 75–200 kc/s., 200–500 kc/s., 600–1,500 kc/s., 3–7.5 mc/s., 7.5–18.5 mc/s. Fully tested before despatch. Complete with circuit and instruction booklet, **£8/10/-,** carriage 10/-.

OSCILLOSCOPE ! !

Latest Ministry release of Test Set type 43. Employs 3½in. CRT type VCR 138A, 4–6J7, 4–VR54, 1–5Z4, 1–VU120. Panel controls: X shift, Y shift, Focus, Brilliance, External or internal sync., Four speed time base. Internal H.T. & E.H.T. Mains power pack. Size 12in. × 9in. × 18in. Complete with leads. Brand New and Unused



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SPECIAL VIBRATOR PACKS

12 VOLT input, 300 volts output at 150 m/A. As a bridge rectifier will handle 450 volts RMS at 120 m/A. Pack consists of 12 volt vibrator, 4 metal rectifiers, chokes and smoothing condensers. ONLY **30/-,** carriage 5/-.
6 VOLT input, 230 v. output at 100 mA., complete 4-pin vibrator, OZ4 rectifier. Fully smoothed, **25/6** each. P. & P. 2/6.

WHEATSTONE BRIDGE

Consisting of four stud switches: 0–10 ohms, 0–100 ohms O-INF. Galvanometer centre zero F.S.D. 2.5mA. Ranges easily extended. Housed in oak cabinet 16×7½×6in. Complete with instructions, **40/-.**

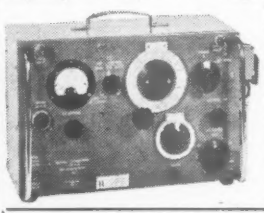
P. & P. 4/-.

BENDIX RECEIVER RA 10

A 4 wave-band superhet covering 150 kc/s.–10 mc/s. Valves 6SK7 1st R.F 6K8 Mixer. 6SK7 1st and 2nd I.F. 6R7 2nd Det. 6C5 B.F.O. 6K6 output. Size 6½×15½in. Easily converted to mains operation as described on page453 of the September "Practical Wireless." **£5/10/-,** carr. 7/6.

SIGNAL GENERATOR TYPE 52A

Frequency 6–52 Mc/s. in four ranges



Internal mains pack, extensively filtered. 50μ amp. R.F. Meter. Internal or external modulation. Calibrated coarse and fine (in μV) attenuator, output impedance 70 or 100 ohms, minimum output 0.5μ volts, maximum output 100 mV. Complete with all leads, calibration charts and circuit. Brand New in original manufacturer's cases **£8/10/-,** carr. 10/-.

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5U4G	7/6	6K7	5/–	9006	3/6	SP61	3/–
6AC7	5/–	6SH7	6/–	12A6	6/6	VR116	3/–
6AG7	9/6	6SL7GT	7/–	12J5	6/–	VR15030	6/–
6AK5	6/6	6SN7GT	6/6	12SH7	5/–	VT501	3/–
6C4	3/6	6V6GT	7/6	EA50	1/6	446B	25/–
6H6	2/6	955	1/9	EB34	1/6	464A	25/–
6J5	4/6	956	1/9	EF50	3/–	1625	5/–

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0-25 AMPS. 2½in. ROUND FLUSH MOUNTING METERS. New and boxed, **8/6.** Post 1/6.

SIGNAL GENERATOR AND WAVEMETER . Type W.1649. Frequency of Sig nalgenerator: 140 to 240 Mc/s Accuracy +0.5 Mc/s. Frequency of Heterodyne Wavem ter: 155-255 Mc/s Accuracy + 0.2 Mc/s. Containing VR 135 and 4VR91, 5 meg. crystal. Retractable aerial. Power requirements: 6.3 volts and 120 volts. Unit housed in copper lined wooden case. Size 15½in. x 13in. x 14½in., **45/-,** plus 10/- carr.

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TANNOY AMPLIFIER. With 4 6L6's in parallel, push-pull handling from 30 to 60 watts. 200-250 v. input. Complete with all leads, hand microphones, plugs and spares. Housed in wooden transit case 17½ x 15½ x 11½in. with full operating instructions and circuit. Fully tested. ONLY **£20.** Speakers for above **25/-** each.

WESTINGHOUSE PENCIL RECTIFIER. Type J.50 output 500 v. at 5 mA. 5/- post paid.

AMERICAN ROTARY CONVERTORS. With cooling Fan. Input 12 v. D.C. Output 250 v. at 90 mA. Completely suppressed. Brand new, **19/-** each, plus P. & P. 3/-.

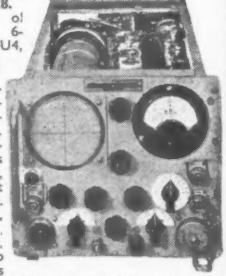
COLVERN WIRE WOUND POTENTIOMETERS. 25 watts 50k and 100k. Price **6/-** each.

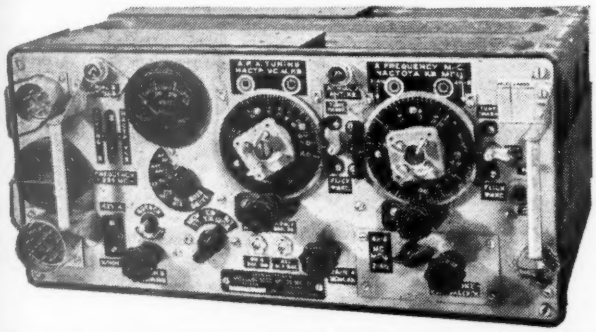
HEADPHONE & MICROPHONE ASSEMBLY. Consisting of padded headphones and No. 7 moving coil hand microphone with cord and plug. Brand new. Price **10/-.**

PYE 45 mc/s. I.F. STRIPS. Complete with seven valves, 6-EF50, 1-VR92, 6 tunable I.F. transformers. Only **30/-,** post paid.

COMMAND RECEIVERS. 1.5–3 Mc/s., fully valved, with circuit, **65/-,** P. & P. 3/6.

MONITOR TYPE 28. Consists of VCR138 6-SP61, 1-SU4, 1-VU120, 3-EA50.1 M/A meter scaled 100-0 - 100v. Incorporates Y shift, X shift in u/sec. Focus, sync., Bias, Input to X plates switched ×20. ×5 and direct, requires only suitable power pack for use as oscilloscope. **60/-,** carr. 10/-.





WIRELESS SET

No. 19 MK. II

The famous Army Tank Transmitter-Receiver. Incorporates "A" set (TX/RX covering 2.0-8.0 Mc/s., i.e., 37.5-150 metres); "B" Set (VHF TX/RX covering 230-240 Mc/s., i.e., 1.2-1.3 metres), and Intercomm. Amplifier. Complete with 15 valves as follows: 6 of 6K7G, 2 of 6K8G, 2 of 6V6G, and 1 ea. 6B8G, 6H6, E1148, EF50, 807, and booklet giving circuits, notes, etc. Size 17½in. x 8½in. x 12½in. Of American manufacture as previously offered by us, but another large release by the Ministry of Supply enables us to make a substantial reduction in price. In magnificent condition.

BRAND NEW AND UNUSED, ONLY **65/-** (carriage, etc., 10/-).
12-volt Power Units available **25/-** (carriage 5/-).

OSCILLOSCOPE

The Ministry of Supply Monitor Type 61 (as illustrated last month) is a First-Grade Synchroscope designed for D.C. Pulse and R.F. Envelope investigation, and employs a 3½in. CRT type VCR138A. The R.F. Frequency is 180-220 Mc/s. approx.; and is tuneable in that range. Has internal 500 kc/s. Calibrating Oscillator on Y Plates. Existing Time Base Speeds are 50 cycles, 20 Microseconds fast, and 1,000 Microseconds slow. Conservatively rated Mains Power Pack is for nominal 115 v. and 230 v. Will make up into an excellent General-Purpose Oscilloscope at a cost of a few shillings, full modification data being supplied. Front panel size is 10½in. x 12½in., depth of unit being 19in. **BRAND NEW AND UNUSED, ONLY £12/10/-** (carriage, etc., 15/-).

COMMUNICATIONS RECEIVER R.107

Just purchased from the Ministry of Supply, this magnificent 9 valve 3 Wave-band receiver gives World Wide Reception over a coverage of 1.2—17.0 Mc/s. (18-250 metres), taking in several important Amateur Bands, Shipping Band, and part of the Medium Wave Band, including the B.B.C. Light Programme. The Sensitivity is 1 micro-volt on C.W., and 2-6 micro-volts on R.T. The controls include a Bandwidth Switch ("Wide" or "Narrow"), choice of AVC and BFO, Audio Filter, RF Gain, Aerial Trimmer. Has built-in Output Stage with Internal Speaker, which can be switched out to use Headphones. Uses normal International Octal Valves. Incorporates AC Mains Power Unit for 100-250 volts, and Vibrator Pack for 12 volts D.C. In grey metal case, size 24 x 13 x 17in. These sets are slightly used, but in first-class condition, thoroughly checked and aerial tested before despatch. Complete, ready to switch on ONLY **£8/19/6** (carriage 20/- England and Wales, rest of U.K. extra). S.A.E. for leaflet.

MARCONI SIGNAL GENERATORS TF390G. Frequency coverage 16-150 Mc/s. BRAND NEW IN MAKER'S ORIGINAL TRANSIT CASES, with instruction manual. For normal A.C. mains operation. A unique opportunity to acquire Laboratory Equipment at a fraction of original cost. ONLY **£25.**

MARCONI SIGNAL GENERATOR TF144G. Frequency coverage 85 kc/s. to 25 Mc/s., and known as a Laboratory Standard. For normal A.C. mains, and complete with all leads. Reconditioned AS NEW. ONLY **£65.**

R1155 SUPER SLOW-MOTION TUNING ASSEMBLY. As used on all late model 1155s. Easily fitted to "A" sets, etc. ONLY **12/6.**

ROLA 6½in. P.M. SPEAKER. Mounted in Grey crackled metal cabinet 9in. x 9in. x 4½in., and with volume control. BRAND NEW AND UNUSED. ONLY **27/6.**

EHT TRANSFORMERS. 5.5 kV. (Rect.) with 2 v. 1 a., **79/6**, 7 kV. (Rect.) with 2 v. 1 a., **89/6**. 2.5 kV. (Rect.) with 2-0-2 v. 1.1 a., 2-0-2 v. 2 a. (for VCR 97 tube, etc.), **42/6** (postage 2/- per trans.).

500 MICROAMPS METER. 2in. circular as used on British No. 19 Wireless Sets. Calibrated 0-15 and 0-600 volts, resistance 500 ohms. A very fine instrument, and A SNIP AT ONLY **15/-.**

MARCONI SIGNAL GENERATORS TF-517-F/1. Special offer of these Laboratory Signal Generators. Cover 10-18 Mc/s., 33-58 Mc/s. and 150-300 Mc/s. In good, used condition, with charts. Checked before despatch. Complete with power pack for normal A.C. mains. ONLY **£12/10/-** (carriage, etc., 20/-).

TCS TRANSMITTERS

The renowned American TCS Model designed by the Collins Company for static or mobile use. Covers 1.5-12.0 Mc/s. in 3 bands, and is complete with 7 valves, employing 2 of 1625 in P.A. Stage, 1 each of 1625 in Buffer and Modulator Stages, and 3 of 12A6 in Oscillator Stage. Provision for VFO or Crystal Control. 4 Crystal positions. Radio Telephone or Radio Telegraph. Has Plate and Aerial Current Meters. Power requirements 12 v. LT & 400 v. HT. In black crackle case, size 11 x 13 x 11in., condition BRAND NEW and UNUSED. ONLY **£12/10/-** (carriage, etc., 15/-).
The double Dynamotor Power Unit, Type 21881B for 12-volt operation, delivering 400 v. for Transmitter and 225 v. for Receiver, is available at **£12/10/-** (carriage, etc., 15/-).

METERS

F.S.D.	SIZE AND TYPE		PRICE
50 microamps D.C.	2½in.	Flush circular	59/6
500 microamps D.C.	2in.	Flush square	27/6
1 mA D.C.	2in.	Flush square	22/6
150 mA. D.C.	2in.	Flush square	7/6
200 mA. D.C.	2½in.	Flush circular	12/6
10 amps D.C.	3½in.	Proj. circular	20/-
20 amps D.C.	2in.	Proj. circular	7/6
40 amps D.C.	2in.	Proj. circular	7/6
15-0-15 amps D.C.	3½in.	Flush square	25/6
300 volts D.C.	2in.	Flush square	10/6
300 volts A.C.	2½in.	Flush circular	25/-

MARCONI BAND III CRYSTAL CALIBRATORS. Frequency range 170-240 Mc/s. Incorporates 5 Mc/s. crystal for better than .001 per cent. accuracy. Directly calibrated dial, internal A.C. mains pack. Complete with spare set of valves and instruction manual in maker's transit cases. BRAND NEW. ONLY **£4/19/6.**

12-WAY SCREENED CABLE. In 10ft. lengths, fitted with plugs, originally made for use with the 19 Set. UNUSED. ONLY **17/6** per lead.

POCKET VOLTMETERS. Not ex-Govt. Read 0-15 v. and 0-300 v. A.C. or D.C. BRAND NEW AND UNUSED, ONLY **18/6.**

CRYSTALS. British Standard 2-pin 500 kc/s. **15/-.** Miniature 200 kc/s. and 465 kc/s. **10/-** each.

SPECIAL MAINS TRANSFORMER OFFER. Normal 230 v. A.C. Primary. Secondaries 330-0-330 v. 100 mA. 4 v. 3 amps. Ex-W.D., BRAND NEW AND UNUSED. ONLY **15/-.** (Postage etc. 2/6.)

CHOKES. 10H 60 mA. **4/-.** 5H 200 mA. **7/6.**

FILAMENT TRANSFORMERS. 6.3 v. 1½ amps. **7/6.** 6.3 v. 3 amps. **10/6.**

6 v. VIBRATOR PACKS. Output approx. 130 v. at 30 mA., fully filtered and smoothed Complete. ONLY **12/6.**

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C.R.T. ISOLATION TRANSFORMERS

For Cathode Ray Tubes having Heater/Cathode short circuit and for C.R. Tubes with falling emission.
Type A. Low leakage windings. Ratio 1 : 1.35 giving a 25% boost on Secondary.

2 volt	10/6 each
4 volt	10/6 each with Tag
6.3 volt	10/6 each Panel and
10.8 volt	10/6 each Solder Tags
13.3 volt	10/6 each
Ditto with mains primaries	12/6 each

Type B. Mains input 220/240 volts. Low Capacity. Multi Output 2, 4, 6.3, 7.3, 10 and 13 volts. Input has two taps which increase output volts by 25% and 50% respectively. This transformer is suitable for all Cathode Ray Tubes. With Tag Panel 21/- each. Ditto for 6 volt Tubes only 17/6.
Type C. Low capacity wound transformer for use with 2 volt Tubes with falling emission. Input 220/240 volts. Output 2-2½-21-21-3 volts at 2 amps. 17/6 each.
All Isolation Transformers are individually boxed, labelled and clearly marked with relevant data.
NOTE:—It is essential to use mains primary types with T.V. receivers having series connected heaters.

RESISTORS. All preferred values. 20% 10 ohms to 10 meg., ½ w. 4d.; ¼ w., 4d.; 1 w., 6d.; 1½ w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w. 1%, 2/-. All preferred values 100 ohms to 10 meg. Ditto 10% 6d.

WIRE-WOUND RESISTORS
5 watt, 10 watt, 15 watt } 1/3, 1/6, 1/9
25 ohms—10,000 ohms
15,000 ohms—50,000 ohms, 5w., 1/9; 10 w. 2/3

WIRE-WOUND POTS. 3 WATT LAB. COLVERN, ETC.
Pre-set Min. T.V. Type Knurled Slotted Knob. All values 25 ohms to 30 K., 3/- ea. 50 K., 4/-. Ditto Carbon Track 50 K. to 2 Meg., 3/-.
Standard size Pots., 2½in. Spindle High Grade. All Values, 100 ohms to 50 K., 5/6; 100 K. 6/6.
W/W EXT. SPEAKER CONTROL 10Ω, 3/-.

O/P TRANSFORMERS. Heavy Duty 50 mA., 4/6. Multi-ratio push-pull, 7/6. Miniature 3V4, etc., 4/6. Hygrade Push-pull 7 watts, 15/6.
L.F. CHOKES 15/10 H. 60/65 mA., 5/-; 25/20 H. 100/120 mA., 11/6; 20/15 H., 120/150 mA., 12/6; 5 H. 250 mA., 15/-.
MAINS TRANS. 350-0-350, 80 mA., 6.3 v. tapped 4 v. 4 a. 5 v. tapped 4 v. 2 a., ditto 250-0-250 80 mA., etc., 22/6. Bargain 300-0-300 v. 65 mA., 6 v. 4 a., 4 v. 2 a., 15/-

I.F. TRANSFORMERS 7/6 pair

465 kc/s slug tuning miniature can 2½ × 1 × 1in. High Q and good band width. 10y Pye Radio. Data sheet supplied.
Wearite M800 I.F. transformers 465 kc/s, 12/6 pair.
Wearite 550 I.F. transformers 465 kc/s, 12/6 pair.

HEATER TRANS. Tapped 200/250 v. 6.3 v. 1½ amp., 7/6.
ALADDIN FORMERS and cores. ½in., 6d.; ¾in., 10d. Can. FORMERS 3937/8 and Cans TV1/2. ½in. sq. × 2½in. and ¾in. sq. × 1¼in., 2/- complete with cores.
SLOW MOTION DRIVES. Epicyclic ratio 6 : 1, 2/3.
TYANA. Midget Soldering Iron. 200/220 v. or 230/250 v., 16/3. SOLON INSTRUMENT IRON. 25 w., 24/-.
MAINS DROPPERS. 3×1½in. Three Adj. Sliders. .3 amp. 750 ohms, 4/3. .2 amp. 1,000 ohms, 4/3.
LINE CORD. .3 amp., 60 ohms, per foot, .2 amp., 100 ohms per foot, 2 way, 6d. per foot, 3 way, 7d. per foot.

CRYSTAL MIKE INSERT by Acos

Precision engineered. Size only 1½ × 3/16in. Bargain. Price 6/6. No transformer required.

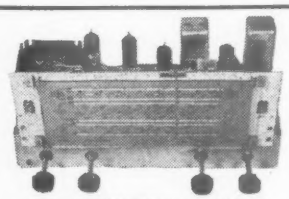
MIKE TRANSF 50 : 1, 3/9 ea.; 100 : 1, Potted, 10/6.
LOUDSPEAKERS P.M. 3 OHM. 2½in. square, 17/6.
5in. R.A., 17/6 ... 7in. × 4in. Goodmans 21/-.
3½in. Square Elac., 19/6. 8in. Plessey, 19/6
6½in. Goodmans, 18/6 10in. R.A., 30/-.
4in ELAC TWEETER, 25/-. 12in. Plessey, 30/-.
8in. M.E. 2.5 k. field tapped O.P. transformer, 24/6.
15 ohm Plessey 10 wt. 12in. with Tweeter, 97/6.
CRYSTAL DIODE G.E.C., 2/-. GEX34, 4/-. 40 Circuits, 3/-.

TELETRON CRYSTAL SET

Comp'ete kit with cabinet 4½ × 3 × 1½in. All components and instructions. 15/- or 30/- with pair of H.R. headphones to match.

H.R. HEADPHONES. 4,000 ohms, brand new. 16/6 pair.
SWITCH CLEANER Fluid, squirt spout, 4/3 tin.
TWIN GANG CONDENSERS. 365 p.f. Miniature, 1½in. × 1½in. × 1½in., 10/-. .0005 Standard with trimmers, 9/-; less trimmers, 8/-. Midget, 7/6; Single 50 pf., 2/6. Solid Dielectric 100, 300, 500pf., 3/6 each.
VALVE HOLDERS. Pax int. Oct., 4d. EF50, EA50, 6d. B12A, CET, 1/3. Eng. and Amer. 4, 5, 6, 7 and 9 pin, 1/-. MOULDED Mazda and Int. Oct., 6d., B7G, B8A, B8G, B9A, 9d. B7G with can, 1/6. VCR97, 2/6. B9A with can, 2/6. CERAMIC, EF50, B7G, B9A Oct., 1/-. B7G with can, 1/9. SPEAKER FRET. Gold Cloth 17in. × 25in., 5/-. 25in. × 36in., 10/-. Expanded metal, Silver 15½in. × 9in., 2/-. Tygan 4ft. 6in. wide, 10/- ft.; 2ft. 3in. wide, 5/- ft.
WAVECHANGE SWITCHES.
2 p. 2-way 3 p. 2-way, short spindle 2/6
5 p. 4-way 2 wafer, long spindle 6/6
2 p. 6-way, 4 p. 2-way, 4 p. 3-way, long spindle 3/6
3 p. 6-way, 1 p., 12-way, long spindle 3/6
Wave change "MAKITS," 1 wafer 8/6; 2 wafer 12/6; 3 wafer 16/-; 4 wafer 19/6; 5 wafer 23/-; 6 wafer 26/6.
TOGGLE SWITCHES. S.P., 2/-; D.P. 3/6; D.P.D.T. 4/-.
MORSE KEYS, good quality 2/6

KNOBS GOLD ENGRAVED. Walnut or Ivory. 1¼in. diam., 1/6 each. "Focus." "Contrast." "Brilliance." "Brilliance—On/Off." "On-Off." "Volmue." "Volt-On-Off." "Tone." "Tuning." "Treble." "Bass." "Wavechange." "Radio Gram." "S.M.L. Gram." "Record-Play." "Brightness," ditto, not engraved, 1/-.



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THREE WAVEBANDS
S.W. 16m.—50 m.
M.W. 200 m.—550 m.
L.W. 800 m.—2,000 m.
12 month Guarantee. A.C. 200/250 v., 4-way switch. Short-Medium-Long-Gram. A.V.C. and Negative feedback. 4.2 watts. Chassis 13½in. × 5½in. × 2½in. Glass Dial 10 × 4½in. horizontal or vertical available. 2 Pilot Lamps. Four Knobs, Walnut or Ivory, aligned and calibrated. Chassis isolated from mains.

FIVE VALVES
LATEST MULLARD
ECH42, EF41, EBC41, EL41, EZ40

BRAND NEW **£10.10.0** Carr. 4/6.

TERMS: Deposit £5/5/- and 6 monthly payments of £1.
MATCHED SPEAKERS FOR ABOVE CHASSIS: 8in., 17/6; 10in., 25/-; 12in., 30/-.

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HIGH FIDELITY AUTOCHANGER
MODEL RC456

For 7", 10", 12" Records 16, 33, 45, 78 r.p.m.
4-SPEEDS—10 RECORDS
WITH STUDIO "O" PICK-UP
BRAND NEW IN MAKER'S BOXES

OUR PRICE £9.15.0 Post free.
TERMS: Deposit £5/5/- and 6 monthly payments of £1.
SUITABLE PLAYER CABINETS 49/6
AMPLIFIER PLAYER CABINETS 63/-

GARRARD 4-SPEED SINGLE RECORD PLAYER 4SP

Brand new and fully guaranteed 12 months

AUDIO PERFECTION

Designed to play 16, 33, 45, 78 r.p.m. Records, 7in., 10in., 12in. Lightweight Xtal pick-up, GC2 turnover head, two separate sapphire styli, for Standard and L.P., each plays 2,000 records. Voltage 200/250 A.C.

OUR PRICE £8.0.0 each. Post Free.
Terms: Deposit £5 and 4 monthly payments of £1. Space required 14in. x 12½in. 3in. above and 2½in. below.
Amplifier Player Cabinets, 45/-.

BUILD THIS REPRODUCER BARGAIN SPECIAL SINGLE PLAYER KIT

FAMOUS MAKER'S SURPLUS STOCKS

4-speed Collaro "Junior" Unit... £4 12 6
Handsome portable case, 17½ x 13½ x 7in. £2 5 0
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All available separately or if all purchased together
£9.15.0 complete kit post free.

HANDY VOLTMETERS

2in. Twin Range 0-25 v., 0-250 v. d.c. with leads and leather case, 12/6 each.

COSSOR COMPANION
SUPERHET MODEL 527/X FOR ALL-DRY BATTERY OPERATION

S.W.1 13.6 to 43 metres, S.W.2. 42.8 to 136 metres, Medium 187 to 575 metres.
A fine all-wave receiver giving world-wide reception on three wavebands. Operation is from a single dry battery, very economical low consumption valves 1AC6, 1AJ4, 1AH5, 3C4.

6in. ELLIPTICAL LOUDSPEAKER

The cabinet is attractively presented in maroon and beige with gold trimmings.
SIZE 9½ × 6¾ × 4¼in. Leaflet S.A.E.
OUR PRICE £6.15.0 (Battery extra) 19/6
Carriage and insurance 4/6

TELETRON BAND III CONVERTER

For London, Midland and Northern I.T.A.
Suitable all T.V. makes, T.R.F. or Superhet. Coils, valves, components, chassis, wiring plans. COMPLETE KIT for mains operation 200-250 v. A.C., £3/10/-. As ABOVE less POWER PACK. Requires 200 v. 20 mA. H.T., 6.3 v., 6 a. L.T., £2/5/-.
Mark II cascode £1 extra each Kit.

Volume Controls

Midget size
Long spindles. Guaranteed 1 year. All values 10,000 ohms to 2 Meg.
No. Sw. S.P.Sw. D.P.Sw.
3/- 4/- 4/9
Linear or Log Tracks

80 ohm CABLE Coaxial

Semi-air spaced Polythene insulated ½in. dia. Stranded core. Ideal Band III. 9d. yd. Losses cut 50%.

FRINGE QUALITY
AIRSPACED .... 1/6 yd.

COAXIAL PLUGS 1/- DOUBLE SOCKET 1/3
SOCKETS 1/- OUTLET BOXES 4/6
BALANCED TWIN FEEDER per yd. 6d. 80Ω or 300Ω.
TWIN SCREENED BALANCED FEEDER 1/- yd., 80 ohms.
TRIMMERS, Ceramic, 30, 50, 70 pf., 9d. 100 pf., 150 pf. 1/3. 250 pf., 1/6. 600 pf., 750 pf., 1/9. Phillips, 1/- ea.

ALUMINIUM CHASSIS. 18 s.w.g. Plan, undrilled, with 4 sides, riveted corners and lattice fixing holes, with 2½in. sides. 7 × 4in., 4/6; 9 × 6in., 5/9; 11 × 7in., 6/9; 13 × 9in., 8/6; 14 × 11in., 10/6; 15 × 14in., 12/6; and 18 × 16 × 3in., 16/6.

BLACK CRACKLE PAINT. Air drying, 3/- tin.
P.V.C. CONN. WIRE, 10 colours, single or stranded, 2d. yd.
NEON MAINS TESTER SCREWDRIVERS, 5/-.
MULTICORE SOLDER 60/40, 18 s.w.g., 3d.; 16 s.w.g., 4d. yd.

12/6 PURETONE RECORDING TAPE

1,200 ft. on standard fitting 7in. metal reels. Spare Reels 7in. metal 2/3; 7in. plastic, 4/3.
FERROVOICE 1,200ft. Plastic Tape 25/- on plastic reels.

SENTERCEL RECTIFIERS. E.H.T. TYPE FLY-BACK VOLTAGES. K3/25 2 kV., 5/-; K3/40 3.2 kV., 7/-; K3/45 3.6 kV., 7/6; K3/50 v. 4 kV., 8/-; K3/100 8 kV., 14/6. 50 c.p.s. Voltage 30% of above.
MAINS TYPE, RM1, 125 v., 60 mA., 5/-; RM2, 100 mA., 6/-; RM3, 120 mA., 8/-; RM4, 250 v., 275 mA., 16/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v. 50 m/a., 8/6; 250 v. 85 m/a., 9/6.
COILS. Wearite "P" type, 3/- each. Osmor Midget "Q" type adj. dust core, from 4/- each. All ranges.
TELETRON, L. and Med. T.R.F., with reaction, 3/6.
FERRITE ROD AERIALS. M.W., 3/9; M. and L., 12/6.
T.R.F. COILS A/HF, 7/- pair. H.F. CHOKES, 2/6.

JASON F.M. TUNER COIL SET, 26/-. H.F. coil, aerial coil, Oscillator coil, two I.F. Transformers 10.7 Mc/s., Detector transformer and heater choke. Circuit and component book using four 6AM6, 2/-. J.B. Chassis and Dial, 19/6. Complete Kit, £5/18/6.
With Jason superior calibrated dial, £6/15/-.
Mercury Complete Kit £9/19/6.

CONDENSERS. New stock. .001 mfd. 7 kV. T.C.C., 5/6. Ditto 20 kV., 9/6; 100 pf. to 500 pf. Micas, 6d.; Tubular 500 v. .001 to .01 mfd., 9d.; .05, .1, 1/-; .25, 1/6; .5, 1/9; .1 350 v., 9d.; 0.1 mfd. 2,000 v., 3/6; 0.01 mfd. 2,000 v. 1/9.
CERAMIC CONDS. 500 v. .3 pf. to .01 mfd., 10d.
SILVERED MICA CONDENSERS. 2 pf. to 500 pf., 1/-; 600 pf. to 3,000 pf., 1/3. CLOSE TOLERANCE (± 1 pf.) 1.5 pf. to 47 pf., 1/6d. DITTO 1% 50 pf. to 815 pf. 1/9; 1,000 pf. to 5,000 pf., 2/-.

NEW ELECTROLYTICS. FAMOUS MAKES.

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	100/25 v.	3/-	8+16/450 v.	5/-
2/450 v.	2/3	8+8/500 v.	4/6	16+16/500 v.	6/-
4/450 v.	2/-	16+16/500 v.	6/-	6,000 mfd. 6 v.	6/6
8/450 v.	2/3	CAN TYPES		32+32/350 v.	4/6
8/500 v.	2/9	Clips	3d.	32+32/450 v.	6/6
16/450 v.	3/6	16/450 v.	3/6	64+120/275 v.	7/6
16/500 v.	4/-	32/350 v.	4/-	60+100/350 v.	11/6
32/450 v.	5/6	64/350 v.	5/6	100+200/275 v.	12/6
25/25 v.	1/9	100/275 v.	5/6		
50/25 v.	1/9	50+50/350 v.	7/-	1,000+1,000/6 v.	6/6
50/50 v.	2/-	500/12 v.	3/-		

FULL WAVE BRIDGE SELENIUM RECTIFIERS. 2, 6 or 12 v. 1½ amp., 8/9; 2 a., 11/3; 4 a., 17/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v. for charging at 2, 6 or 12 v. 1½ a., 15/6; 2 a. 17/6; 4 a., 22/6.

VALVES

All boxed. New & Guaranteed

1R5	8/6	6K8	8/6	EABC80	8/6
1S5	8/6	6L6	10/6	EB91	6/6
1T4	8/6	6Q7	10/6	EBC33	8/6
3S4	8/6	6SA7	7/6	EBC41	10/6
3V4	8/6	6SN7	8/6	EBF80	8/6
5U4	8/6	6V6G	7/6	ECC84	12/6
5V3	8/6	6V6GT	8/6	ECF80	10/6
5Z4	10/6	6X4	7/6	ECF82	10/6
6AM6	8/6	6X5	7/6	ECH42	10/6
6B8	5/6	787	8/6	ECL80	12/6
6BE1	7/6	12A6	7/6	ECL82	12/6
6BH6	10/6	12AH8	10/6	EF39	7/6
6BW6	8/6	12AT7	10/6	EF41	10/6
6BW7	8/6	12AU7	10/6	EF50	5/6
6CH6	10/6	12AX7	10/6	Equip.	
6D6	7/6	12BE6	10/6	EF80	8/6
6F6	7/6	12BH7	10/6	Sylv.	
6H6	3/6	12K7	8/6	EF80	10/6
6J5	6/6	12Q7	8/6	EF92	5/6
6J6	7/6	35Z4	10/6	EL32	5/6
6J7	8/6	80	8/6	EL84	10/6
6K6	6/6	954	1/6	EY51	11/6
6K7	5/6	EA50	1/6	EZ40	10/6
				EZ81	11/6
				E1148	1/6
				HABC80	12/6
				HVR2A	7/6
				MU14	10/6
				P61	6/6
				PCC84	12/6
				PCF80	10/6
				PCF82	10/6
				PCL82	10/6
				PEN25	6/6
				PL82	10/6
				PY80	10/6
				PY81	10/6
				PY82	10/6
				SP61	5/6
				UBC41	10/6
				UCH42	10/6
				UF41	10/6
				UL41	10/6
				UY41	10/6
				Y22	10/6
				X79	10/6

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TEL. THO 1665. Buses 133 or 68 pass door. S.R. Stn. Selhurst. 48-hour postal Service. *P. & P. 1/-, £2 orders post free (Export extra). C.O.D. Service 1/6*

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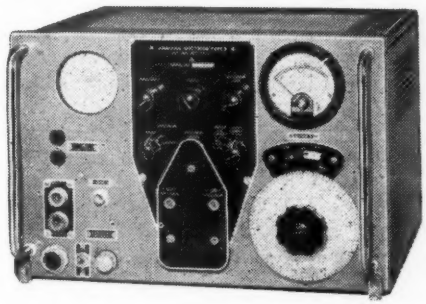
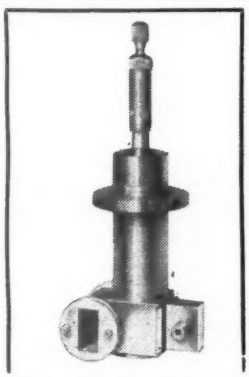
MARCONI

S-BAND (10 cm) SPECTRUM ANALYSER Type TF984



FREQUENCY RANGE	2,900 to 3,150 Mc/s.
SENSITIVITY	200 Micro Watt for 5 cm deflection. 20 Mean Watt for 5 cm. deflection.
SPECTRUM WIDTH	1 to 10 Mc/s.
SWEEP FREQUENCY	4 to 10 Mc/s.
I.F.	22.5 Mc/s.
I.F. BANDWIDTH	100 kc/s for 3 db drop in level.

Prices given on request.



MICRO METRIC TUNABLE CAVITY

3 c/m BRITISH WAVEGUIDE

New £15. each

Calibration undertaken if required.

FREQUENCY METERS

BC221 Range 125 kc/s—20 Mc/s *In perfect condition*

Also in stock: **U.S.A. BENDIX LM SERIES**

Aircraft version of BC221.

TS174 40—250 M/cs.

TS175/U 85—1000 M/cs.

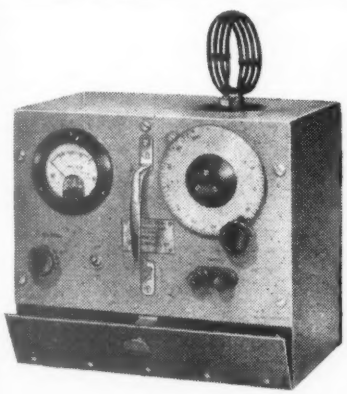
Prices upon written request.

MANUALS

for Communication Receivers *AR88D-LF, AR77E, HQ120, HQ129X, R107, S20R, SX24, SX28, B2, TX/RX, HRO's at £1/7/6 each and others supplied to order from our library.*

ALSO AVAILABLE FROM STOCK

Multi Range Test Meters, Marconi Signal Generators, Meggers, Audio Oscillators, Oscilloscopes, Communication Receivers, as well as British and U.S.A. V.H.F./U.H.F., 10 cm., 3 cm., 1.5 cm. Test Equipment.



MARCONI

U.H.F. WAVEMETER Type TF 643B

The Instrument is portable self-contained absorption wavemeter with visual resonance indicator.

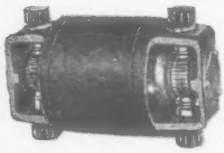
FREQUENCY RANGE	20 Mc/s to 300 Mc/s in four bands of nominally:— 20 to 37 Mc/s., 37 to 70 Mc/s. 70 to 130 Mc/s., 130 to 300 Mc/s. An individual calibration is supplied for each range.
ACCURACY	± 1.0% up to 150 Mc/s. ± 2.0% from 150 to 300 Mc/s.

PRICE £15.0.0 each

DEPENDABLE RADIO SUPPLIES LTD.

12a TOTTENHAM STREET, LONDON, W.1. *(2 minutes Goodge Street Station. Opp. Heals in Tottenham Court Road)*
Phone: LANgham 7391/2. Hours of Business 9-6. Callers welcome. Terms: Cash with order or C.O.D.

ROTARY CONVERTERS Ex-Units



H.T.31
Input 11.5 v. Output 250 v. at 125 mA.
55/-

H.T.32
Input 11.5 v. Output 490 v. at 65 mA.
22/6

P. & P. 3/6. on each.

Both can be supplied tropicalised

We also have stocks of **BRAND NEW ROTARY TRANSFORMERS.**

AS USED IN PYE MOBILE TRANSMITTERS AND RECEIVERS P.T.C. 102 AND P.T.C. 114. Also HUDSON'S MOBILE RADIO TRANSMITTERS AND RECEIVERS.

RELAYS

SIEMENS HIGH SPEED

250+250 coil	8/6
850+850 coil	10/6
1,000+1,000 coil	12/6
1,700+1,700 coil	17/6

LONDEX A.C. RELAYS

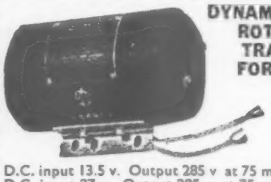
135Ω. .135 to .174 current 50-60 v. 3 make and 1 break. **12/6.**

1,020Ω .056 to .072. Current 150-180 v. 1 make. **10/-.**

9,200Ω. .021 to .027. Current 450-500 v. 1 changeover, 1 break. **15/-.**

P.O. RELAY TYPE 3000

Anode trip changeover. Platinum contacts from 10Ω to 4,000Ω. **10/-.**
Postage & Packing on all relays 1/6.



DYNAMOTOR ROTARY TRANSFORMER

D.C. input 13.5 v. Output 285 v at 75 mA. **57/6.**
D.C. input 27 v. Output 285 v. at 75 mA. **37/6.**
D.C input 12 v Output 250 v. at 50 mA. **47/6.**
Postage & Packing on each **3/6.**

BLOCK CONDENSERS

1 mfd. 600 v.	1/-
1 mfd. 1,000 v.	1/6
2 mfd. 500 v.	1/6
2 mfd. 600 v.	2/-
4 mfd. 350 v.	2/6
10 mfd. 350 v.	3/6

P. & P. 9d.

DELCO ROTARY TRANSFORMERS

Made in U.S.A.

12 volts input. 265 v. output, 120 mA. 24 volts input. 540 v. output, 26 mA. **27/6.** P. & P. 5/-.

PLEASE ADD POSTAGE UNDER £1

LARGER PURCHASES

of all goods advertised enable us to offer

CHEAPER PRICES

QUOTATIONS GIVEN FOR LARGE QUANTITIES
EXPORT ENQUIRIES WELCOMED

HUNDREDS OF BARGAINS FOR CALLERS

Complete Portable Vehicle Loud Hailer operates on 12 v. or 24 v. supply output 6 watts. Can be fixed easily

Comprising Power Pack, Loud Hailer, Hand Powered Microphone. Weatherproof. Very heavy metal case

PRICE EACH **£7/10/-** Carr. & Packing 10/-.

AMERICAN MICA CONDENSERS

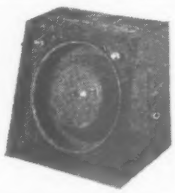
Description			Per doz.	Each
.001	350 v.	V.D.C. Faradon	3/4	4d.
.01	1 000 v.	V.D.C. Cornell Dubilier	10/6	1/1
.001	1,200 v.	V.D.C. Faradon	10/6	1/1
.01	1,200 v.	V.D.C. Faradon	12/-	1/3
.0001	2,500 v.	V.D.C. Faradon	12/-	1/3

Post & packing 1/- per doz. or 3d. each. Please enquire for sizes not stated as we have many in stock.

LOUD HAILERS

EX-GOV.

Impedance 7½Ω Handling cap. 6 watts.
Price **20/-.** Post 3/6



BELLING & LEE FUSE HOLDERS. 1 hole fixing (ex-units) 1/-, 7 pin plugs 6d. P. & P. 6d.

LOUD HAILER SPEAKER UNIT

Impedance 7½Ω. 6-8 watts output. Wt 10lb. Size 7½in. Depth. 10in. Diam. Easy fixing. Weatherproof. Spun solid steel. Hammered finish
PRICE **£3/10/-.**
Carriage & Packing **7/6.**

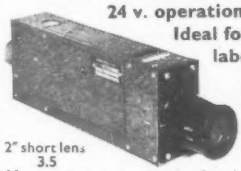
BOTH ITEMS IDEAL FOR SPORTS EVENTS, ELECTIONEERING AND SOCIAL FUNCTIONS.

COMPLETE P.A. SYSTEM

Canadian Telephone loudspeaking Amplifier Unit with 4 loud hailers, powered microphone, headphones and spares. Works off 12 v. D.C. New and boxed, ready for export.
WONDERFUL OPPORTUNITY—CANNOT BE REPEATED.
£7/10/- complete. U.K. Carriage free.
OR SPECIAL OFFER TO CLEAR THE LOT.

BRAND NEW C 45 Govt. Fully modified AIRCRAFT CINE CAMERAS

24 v. operation
Ideal for laboratories



£6.10.0
Post Free in U.K.

2" short lens 3.5

16 exposures per second. Spool carries 25ft of 16 mm. film (1,000 exposures).

BARGAIN OFFER
6–8 volts, .25 amps., or 12–16 volts, .1 amp. **PILOT OR CAR BULBS (American)** M.B.C. 4/6 doz. 25/- per 100.

FLASHLIGHT BULBS (American). 5 v. M.E.S. 3/- doz.

BULLDOG CLIPS. Medium size. Nickel plated on brass, will not corrode. Suitable flying leads, battery chargers, etc. **6d.** each.

BLOWER MOTOR

Overall height 4½in., diam 4in. Operation figures 27 v. at 7,000 r.p.m. 12 v. at 2,800 r.p.m. 6 v. at 380 r.p.m. **17/6.**
Complete with blower **22/6.** P. & P. 2/6.

MINIATURE PLUGS AND SOCKETS
6 pin or 8 pin rear entry. **36/-** doz. **3/3** each. P. & P. 1/6 doz Ex-units.

SPECIAL OFFER
D.L.R. No.5 BALANCE ARMATURE INSETS. Brand new' Price **3/8** each or **36/-** per doz. P. & P. **1/-** each **3/-** doz' These can be put to many uses, i.e., microphones intercom., etc.

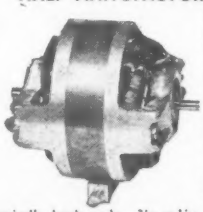
PHILIPS CONCENTRIC TRIMMERS 3/30 PF. Price per doz. **6/6.** Post & Packing 1/- per doz.

TONEON INDICATOR—NEON LAMPS 200/260 v. G.E.C. Worked in series with 300 k res. Price 2/6 each or **24/-** per doz. Post & Packing 6d. each.

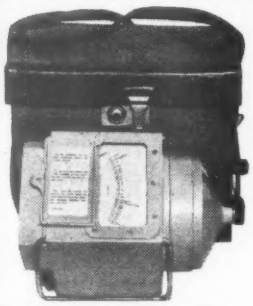
AMERICAN HIGH TO LOW MICROPHONE ADAPTORS. 3½×3½×1¾in., in polished steel case complete with six-pin miniature Jones plug and socket. Price **5/-.** Post & Packing 1/6.

HEAVY DUTY SLIDING RESISTORS
Supplied in two types
250 watts to carry 25 amps Resistance 0.4 ohms, worm drive, also 125 watts, 12 amps. Resistance 1 ohm slider Suitable for charging board, etc. Size 9×4×6in. high. Brand new. Price **12/6.** Post & Packing 3/-.

UNREPEATABLE OFFER LESS THAN HALF MANUFACTURER'S COST



Brand new single phase motor suitable for tape recorders, radiograms, workshops, etc., etc. Has many uses. Reversible 200-230 v. 5in oz. torque. 1,400 r.p.m. Capacitor start. Weight 4½lb. Length overall 5in., spindle both ends. ⅜in.×½in., ⅜in.×½in. Price, incl. P.P and capacitor, **55/-.**



Evershed and Vignoles, Series II, metal cased, **Megger.** 500-volt, used, but in good condition, with leather carrying case. **£20.**

Neon Light, 230 v. A.C. M.B.C. Clear. 1/9 each. P. & P. 6d.

Ultra Violet Bulb, AC/DC, 12 v. 36 watt. New. 5/6 each. P. & P. 6d.

Radial Stud Switch, 20 segs. 5in. sq. Complete with handle and housing. New 5/- each. P. & P. 2/-

METERS
Brand new, guaranteed perfect

5 amp D.C. M.I. 2½in. Fl. Rnd.	11/6
7½ amp. D.C. M.I. 3½in. Rnd. Pr.	12/6
1 mA. M.C. 2½in. Fl. Rnd.	22/6
50 mA. M.C. 2in. Sq.	7/6
200 mA. M.C. 2½in. Fl. Rnd.	9/6
25 v. D.C. M.C. 2in. Fl. Rnd.	7/6
300 v. A.C. M.C. 2½in. Fl. Rnd. ...	22/6

Dual range pocket volt meter 0–25 and 0–250 v., in wallet. **12/6.**
Ex equip. 500 microamp. 2in. M/c. scaled. 0–15 and 0–600 v. **14/6.**
P & P. on all meters 1/– each.

Armour Recording Wire. U.S.A. Top quality on original reels, length 3,700 yards. **17/6.** P & P. 1/6. New.

HEADPHONES

4,000 ohms, imported, new.....	15/–
2,000 ohm, "Ivalek," Brit. New	12/6
L.R. M/c. S. G. Brown	12/6
H.S.30 L.R. U.S.A., min. ear pcs....	15/–

P. & P. on above 1/6 each.

MICROPHONES

Throat, British, magnetic.....	4/6
Throat, carbon, U.S.A.....	3/6
No. 8 carbon with switch.....	7/6
Type 48, ex. oxy. mask.....	3/6

P. & P. on above 1/– each.

Photo Multiplier, Type 931A, for Alfa counting, film scanning, spectography, etc., new. **£2/5/-** each. P. & P. 1/–.

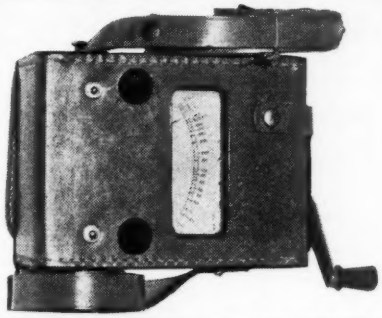
Telephone Handsets, sound power, pair will work by simple connection without batteries. Good condition. **22/6** each. P. & P. 1/9.

Telephone Handsets, U.S.A. Similar to G.P.O., with switch, carbon insert, new. 12/6 each. P. & P. 1/6.

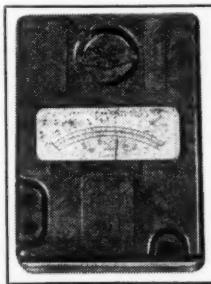
Tannoy Amplifier for 200/250 v. A.C. supply with 4 6L6 in parallel push-pull, max. output 60 watts, complete with all leads, hand microphones, plugs, spares and circuit dia. In wooden carrying case. Fully tested. **£20.** P. & Carr. 8/6.

U.S.A. Geared Motors. 27 v. D.C. Giving twin outputs of 20 r.p.m. and 6 r.p.m. Size 7×1½×in., ¼in. shaft. Will operate on 12. v. Operational condition. 19/6 each. P. & P. 3/–.

Miniature 24 v. D.C. Reversible Recorder Motors. Fitted governor and right angle gear drive, 3×1×1¼in. New. 12/6 each. P. & P. 2/–.

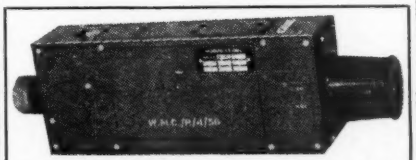


BRAND NEW. EVERSHED AND VIGNOLES "WEE MEGGER," in leather case, guaranteed perfect. 100 volt **£6** each. P. & P. 2/6.
250 volt **£10/10/-** each. P. & P. 2/6.
500 volt **£12/10/-** each. P. & P 2/6.



EVERSHED AND VIGNOLES

Circuit testing ohms meter, pattern "S." Complete with testing prods, inst. book, etc. Two ranges: 0–3 and 0–30 ohms. Brand new, guaranteed perfect, as illus. Offered at fraction of maker's price. **£4/17/6** each. P. & P. 2/6.



AIRCRAFT CAMERA G 45B, Mk. III, fitted with f/3.5 triple anastigmatic lens. Takes 25ft. 16 mm. film. Fitted with 24-volt motor. Mint condition, new in makers' original packing. 16 exposures per second. **£6/10/-** each. P. & P paid.

U.S.A. NAVY MODEL "MAN." Crystal controlled radio transmitter and receiver for voice, by frequency modulated signals in the 30–40 megacycle band Choice of eleven frequencies, powered by 6-volt battery. Complete with valves, crystals, etc., and spares Unused. **£25.** Carr. Eng. **£1.**

15in. RCA U.S.A. P.M. SPEAKER. 15 ohms. Ideal for P.A. Will handle 30 watts. New in maker's carton and case. **£9/17/6** each. Carr. in England 15/–.

LONDEX RELAY. 24 volt heavy silver contacts, two breaks, fair condition. **4/6** each. P. & P. 1/–.
Brand new HIGH-SPEED RELAY. Siemens, 2 bobbins, 1,000 ohms each. **10/6** each. P. & P. 1/–.

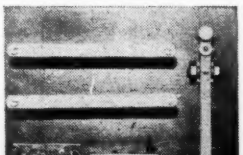
WHEATSTONE BRIDGE UNIT. 4-stud switches. 0–10, 0–100 ohms, galvonometer centre zero, F.S.D. 2.5 mA. In oak carrying case 16×7½×6in. **40/-** each. P. & P. 3/6.

MUIRHEAD VERNIER DRIVE. Scaled 0–180 degrees, ratio 31/1, dia. 3in., as fitted to R.F.26 units. Complete. with lampholder. In manufacturers' original packing. New. **8/6** each. P. & P. 1/6.

Infra-red Telescope, complete with 3-section zamboni pile, image converter tube and full optical system. Brand new, complete with hide carrying case. **17/6** each. P. & P. 2/6.

Infra-Red Spot Light, fitted 12V. 36 watt bulb for use with above. Unused. **12/6** each. P. & P. 2/6.

200/250 v. A.C. Motors. New 1/80 h.p., 2 drives, direct 6000 r.p.m., reduction 300 r.p.m. **22/6** each. P. & P. 2/6.



Morse Practice Set, polished wooden base, tapper, adjustable buzzer, battery clips and terminals. Brand new, original manufacturers' packing. **8/6** each. P. & P. 2/–.

Morse Keys. 8-ampere Service patt. New. **2/6** each. P. & P. 1/–.

Slider Resistance. Heavy duty type, 79 ohms, 2 barrels with gear drive. 2.9 amp.–.65 amp. New. **22/6** each. P. & P. 2/–.

SMOOTHING CHOKES

10H. 150 mA.	450 ohms.	10/6
20H. 50 mA.	300 ohms.	8/6
20H. 100 mA.	270 ohms.	11/6
20H. 150 mA.	160 ohms.	14/6

L.T. Transformer. Input 230 v. Output 50 v., 50 ampere, with meter voltage regulator switch on primary. In steel case fitted with mains switch, will take 100% overload. Grs. wt. 150lb. Wound at 800 amps. per sq. in. New, in manufacturers' cases. **£15.** each. Carr. in Eng. £1.

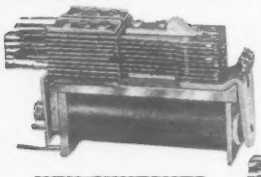
Auto. Transformer, step up, step down, 110 v.–200–220–240 v. Fully shrouded. New, not ex W.D.
300 watt type **£2/2/-** each. P. & P. 4/6.
500 watt type **£3/3/-** each. P. & P. 4/6.
1,000 watt type **£4/4/-** each. P. & P. 4/6.

ASK FOR EXPORT QUOTATIONS — WE ARE EXPERTS AT OVERSEAS PACKING & SHIPPING!

SERVICE TRADING Co.

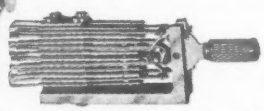
PERSONAL CALLERS ONLY: **9 Little Newport Street, London W.C.2.** *Tel: GER 0576.*
ALL MAIL ORDERS: **47-49 High Street, Kingston-on-Thames.** *Early Closing Thursday*

RELAYS P.O. TYPE 3000.



BUILT TO YOUR SPECIFICATION
QUICK DELIVERY KEEN PRICES
CONTACTS UP TO 8 CHANGEOVER

RELAYS—HIGH SPEED. Miniature, sealed. 1700+1700Ω. **25/-** each. Post 1/3.



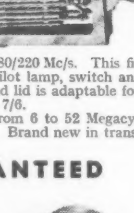
KEY SWITCHES

PROMPT DELIVERY ALL TYPES UP TO 4co/6co

WAVEMETER. With all leads and spares. 180/220 Mc/s. This fine unit contains a 2½in. milliameter 1FSD, 3 valves, pilot lamp, switch and other useful parts. The case 9×9×12½in. with hinged lid is adaptable for many purposes. BARGAIN PRICE **50/-.** Carriage 7/6.
SIGNAL GENERATOR. Type 52a. 4 bands from 6 to 52 Megacycles inclusive. 230 volt. Complete with all leads, etc. Brand new in transit case. **210.** Carriage 7/6.

METERS GUARANTEED

F.S.D.	Size	Type	Price
100 Microamps	2½in.	MC/FR	50/-
250 ,,	3½in.	MC/FR	55/-
500 ,,	2in.	MC/FR	27/6
500 ,,	2½in.	MC/FR	37/6
1 Milliamps	2in.	MC/FR	27/6
1 ,,	2½in.	MC/FR	35/-
5 ,,	2in.	MC/FR	17/6
30 ,,	2½in.	MC/FR	12/6
100 ,,	2½in.	MC/FR	12/6
200 ,,	2½in.	MC/FR	12/6
300 ,,	2½in.	MC/FR	12/6
5 Amperes	2in.	MC/FR	27/6
25 ,,	2½in.	MI/FR	7/6
50-0-50 Amp.	2in.	MC/FR	12/6
20 Volts	2in.	MC/FR	10/6
40 ,,	2in.	MC/FR	10/6
300 ,, A.C.	2½in.	MI/FR	25/-
300 ,, A.C.	6in.	MI/FR	150/-



CROSS POINTER METERS. With 2 separate 100 microamp movements. Brand new. **22/6.** Post 2/-.
CIRCUIT TESTER in case. Meter 50 milliamps. **17/6.** Post **2/6.**
AVO TEST BRIDGES. 220/240 volt A.C. Measures capacities from 5 pf to 50 mfd and resistances from 5 ohms to 50 megohms. Valve voltmeter range 0.1 to 15 volts, and condenser leakage test. BRAND NEW. Full working instructions supplied with instrument. **£9/19/6.** Post 3/-.
TEST SETS incorporating a Wheatstone Bridge, galvanometer. Brand new, in case, **50/-.** Post 3/6.
CELL TESTING VOLTMETERS. 3-0-3. In leather case with prods. A first-quality moving-coil meter. **25/-.** Post 2/-.
OUTPUT POWER METER No. 5, with 3½in. Flush Round Microammeter 100 F.S.D., **90/-.** Post 3/-.
"WEE MEGGER" INSULATION TESTERS, 500 volts, in leather case, **250/-.**
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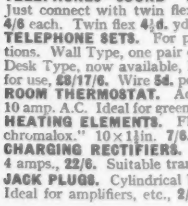

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P. **2/9.** **32 + 32 MFD.** 350 v. 1 1/2in. × 3in. C.S. **3/6.** **40 + 40 MFD.** 150 v. 1in. × 3in. P. **1/6.** **40 + 40 MFD.** 150 v. 1in. × 3in. T. **2/-.** **40 + 40 MFD.** 150 v. 1in. × 2in. W.S. **2/6.** **40 + 40 MFD.** 275 v. 1 1/2in. × 2in. C. **2/9.** **40 + 40 MFD.** 450 v. 1 1/2in. × 3in. P **3/-.** **50 + 50. MFD.** 150 v. 1in. × 2in. T. **2/-.** **50 + 50 MFD.** 275 v. 1 1/2in. × 3in. C. **2/9.** **50 + 50 MFD.** 300 v. 1in. × 3in. T. **3/-.** **50 + 50 MFD.** 300 v. 1 1/2in. × 2in. T. **3/-.** **50 + 50 MFD.** 350 v. 1 1/2in. × 3in. T. **3/6.** **60 + 100 MFD.** 275 v. 1 1/2in. × 3in C. **4/-.** **60 + 100 MFD.** 350 v. 1 1/2in. × 4 1/2in. T. **6/-.** **50 + 250 MFD.** 250 v. 1 1/2in. × 4 1/2in. C. **4/-.** **60 + 250 MFD.** 275 v 1 1/2in. × 4 1/2in. T. **5/6.** **80 + 50 MFD.** 150 v. 1in. × 2in. W.S. **2/-.** **100 + 65 MFD.** 250 v. 1 1/2in. × 3in. P. **4/-.** **100 + 100 MFD.** 350 v. 1 1/2in. × 2in. T. **6/-.** **100 + 200 MFD.** 250 v. 1 1/2in. × 4 1/2in. C. **4/6.** **100 + 200 MFD.** 275 v. 1 1/2in. × 4 1/2in. C. **5/6.** **100 + 250 MFD.** 350 v. 2in. × 4 1/2in. T. **6-** **100 + 400 MFD.** 275 v. 1 1/2in. × 4 1/2in. C. **5/6.** **125 + 200 MFD.** 275 v. 1 1/2in. × 4 1/2in. C. **5/6.** **150 + 200 MFD.** 350 v. 1 1/2in. × 4 1/2in. C. **6-.** **200 + 200 MFD.** 275 v. 1 1/2in. × 4 1/2in. C. **5/6.** **1,000 + 1,000 MFD.** 6 v. 1 in × 3in. C. **3/-.** **8 + 8 + 8 MFD.** 350 v. 1in. × 2in. T. **4/6.** **12 + 12 + 24 MFD.** 275. v. 1in. × 2in. P. **3/-.** **16 + 3 + 4 MFD.** 275 v. 1in. × 2in. P. **2/-.** **16 + 16 + 16 MFD.** 275 v 1in. × 2in. P. **3/-.** **16 + 32 + 32 MFD.** 275 v. 1in. × 3in. C. **3/6.** **20 + 10 + 10 MFD.** 275 v 1in. × 2in. P. **3/-.** **20 + 20 + 20 MFD.** 150 v. 1in. × 2in. P. **2/-.** **25 + 25 + 25 MFD.** 25 v. 1in. × 2in. T.S. **1/6.** **30 + 25 + 20 MFD.** 150 v. 1 1/2in. × 3in. C.S. **2/-.** **32 + 32 + 2 MFD.** 275 v. 1 1/2in. × 2in. 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100 pF., 5 kV. working. 300 pF 8 kV. Test. Price 9d. each.

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6 watt Size: 3/8in. × 1 1/2in. Price 1/- each.
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7 watt Size 3/4in. × 1 1/2in. Price 1/- each
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HIGH STABILITY RESISTORS
1/2 watt, 1/4 watt, 1/8 watt, 1% 2%, 5%. Price 1% **10d.** 2% **8d.** 5% **6d.** Please send lists first.

CERAMIC AND CARBON RESISTORS
1/4, 1/2, 1 watt. **3d.** each. 5% **4d.** each. 1 watt. 4d. each. 2 and 3 watts. 5d. each. Please send lists first.

MAINS DROPPERS
.3 amps., .2 amps., .15 amps., .1 amps. Price **2/6** each.
LARGE VARIETY IN STOCK

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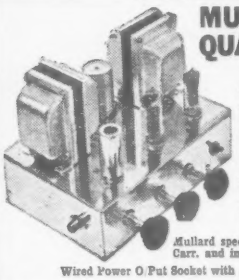

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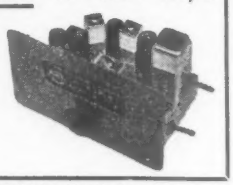

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16/450 v..... 3/6	32+32/275 v. 4/6
16+16/450 v. 5/6	50+50/350 v. 6/6
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SPECIAL PRICE PER SET
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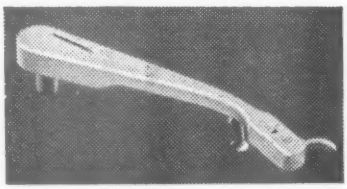

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Illustration shows the long arm model. Price with Dual Sapphire Styli. £14.11.10. Also available with diamond styli.

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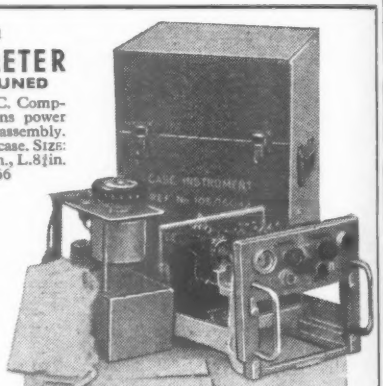

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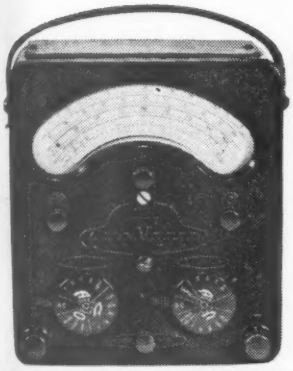

AVOMETER Model D. £8-19-6 (P. & P. 4/-)

D.C. Volts	A.C. Volts	D.C. Current	A.C. Current
150 mV.	7.5 V	15 m/A.	75 m/A.
300 mV.	15 V.	30 m/A.	150 m/A.
1.5 V.	75 V.	150 m/A.	750 m/A.
3 V.	150 V.	300 m/A.	1.5 Amps.
15 V.	300 V.	1.5 Amps.	7.5 Amps.
30 V.	600 V.	3 Amps.	15 Amps.
150 V.	750 V.	15 Amps.	
300 V.	1.5 KV.	30 Amps.	Resistance
750 V.			0-1000 ohms.
1.5 KV.			0-10 K ohms.

Thoroughly overhauled. Complete with batteries and instructions An extremely robust meter at a very reasonable price.

SANGAMO WESTON Model E772 ANALYSER 10 Gns. (P. & P. 4/-)

A.C. and D.C. Volts	D.C. Current	A.C. Current
2.5 V.	100 micro-Amps.	0.5 Amp.
10 V.	1 milli-Amp.	1 Amp.
50 V.	10 milli-Amps.	5 Amps.
250 V.	50 milli-Amps.	
1000 V.	100 milli-Amps.	Resistance
	500 milli-Amps.	0-100 ohms.
		0-1000 ohms.
Output meter		0-100 K ohms.
		0-10 Megohms.

Supplied in neat black Rexine covered carrying case, complete with all batteries and instructions. Thoroughly overhauled and in perfect working order.

CRYSTAL CALIBRATORS, Mk. 2. Ultra modern miniature design, only 9 × 7 × 6½in. Gives 1 Mc/s, 100 Kc/s, and 10 Kc/s marker pips as selected. Requires 60 v. H.T. Controls: On/Off, Modulation On/Off, Adjust 100 Kc/s, Adjust 10 Kc/s. Supplied complete with five 1T4, one 1R5, 1 Mc/s B7G based crystal and headphones. Despatched in specially designed original transit case **ABSOLUTELY BRAND NEW.** £5/19/6.

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MAINS DIMMERS. 300 ohms, 1 amp., 300 watts, twin ceramic formers, 15/-. **CRYSTALS.** 200 Kc/s American GEC, 10/- each. 100 Kc/s RCA bars, 15/-.

COMBINATION VALVE TESTER & MULTIMETER Brand new, ex.-U.S.A. For valve, circuit, capacity, and other testing purposes. In neat black crackled metal case with lid and carrying handle. 15 × 7½ × 5½in. Employs 4in. square-faced 100 micro-Amp. meter. Ranges: 0 to 10, 50, 250, 500 and 1000 v. A.C. and D.C.; 0 to 500, 150 K, 1.5 Meg., and 15 Megohms; 0 to 1, 10, 50 and 250 milli-amps. D.C. Valve tester has provision for "short" tests and inter-electrode voltages and currents. Supplied complete with instructions, valve charts and batteries, ready for use on A.C. mains. £14/19/6. Carr. 7/6.

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A good general purpose portable meter by Precision, U.S.A. Basic FSD 400 micro-Amps. Ranges: A.C. and D.C. volts 0 to 12, 60, 300, 600, 1200 and 6000; D.C. milli-Amps. 0 to 1.2, 12, 60 and 600; Ohms. 0 to 5 K, 500 K, and 5 Meg.; −10 to +16 dB. In polished wooden case with carrying handle and compartment for leads, etc. Size 7½ × 7½ × 5½in. Complete with batteries, tested and guaranteed. £6/19/6. Post 3/-.

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MULLARD C & R BRIDGES
0.1 ohms to 10 Megohms in 4 ranges; 10 pFd to 10 mFd in 3 ranges; Calibrate, Open Bridge, and % ranges. For 100-250 v. A.C. mains. Tested and guaranteed. £7/10/-. Post 3/6.

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TRIPLETT MULTIMETERS
25 Ranges: 0 to 5, 25, 100, 250, 1,000, and 5 kV D.C. (20,000 OPV); 0 to 5, 25, 100, 250, and 1,000 v. A.C. (1,000 OPV); 0 to 50 microA, 1, 10, 100 and 500 mA, 1 and 5 amps. D.C.; 0 to ½, 1, 5 and 10 amps. A.C.; 0 to 1,000, 100 K, and 10 megohms. Square meter, size 4 × 4in. Contained in 11½ × 8 × 5½in., wooden case, weight 10lb Supplied complete with instruction book, batteries, leads and special high voltage leads. **BRAND NEW** ready for use and fully guaranteed. 15 gns. Post 5/-

CERAMIC SWITCHES. Heavy duty (Wearite type), 4 pole, 3 way, 3/6. 2 pole, 6 way, 4 bank, 10/-. **BRAND NEW.**

OUTPUT POWER METERS. Ex-W.D., No 3, Mk. 2 (Windsor 150 A.). Impedance ranges 2.5 to 20,000 ohms in 40 steps. Power ranges 0-5, 50, 500 milli-watts, and 0-5 watts. Also scaled in dB. 3½in M/C meter. In oak case, 10½in × 8in. × 5½in. Tested. £5/19/6. Post 3/6.

HEAVY DUTY BLOWERS. For 200-250 v A.C./D.C. mains, 300 watts. With 1½in. diam. twin "V"-shape outlets. 2 lengths of hose. 4 spare filters and brushes. Suitable for industrial use, forges, etc. **BRAND NEW** £4/19/6. Carr. 12/6.

RCA OUTPUT TRANSFORMERS. As used in MI-11220 Amplifier. Primary for push-pull 6L6's. Secondaries 5, 7.5, 15, and 600 ohms, and tertiary for NFB. 25 watts power rating. Potted construction, with tag connections. Full circuit of RCA amplifier supplied. **BRAND NEW,** 27/6.

HEAVY DUTY SLIDER RESISTORS. 0.4 ohms, 25 amps., 250 watts, worm drive, 7/6. 10 ohms, 3.5 amps., worm drive 10/6. 1 ohm, 12 amps., 150 watts. 7/6.

MINIATURE STC RELAYS. 250 ohms coil. DP C/O(double silver contacts). 1½ × ¾ × ¾in. Wt. one oz. 6 v. operation. 7/6.

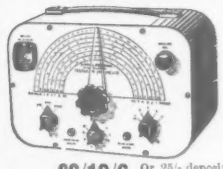
VIBRATOR PACKS. Input 6 v. D.C. Output approx. 100 v. D.C. at 30 m/Amps., fully smoothed and R.F. filtered. Size 6½ × 5 × 2in. Fitted with Mallory 629C vibrator. **BRAND NEW.** Boxed. 12/6. **ANOTHER,** but 200 v. D.C. 100 m/Amps. With OZ4 valve and vibrator. **BRAND NEW.** Boxed. 25/-.

DUAL PURPOSE TRANSFORMERS (Gresham). Pri. 230/250 v. Secs., 240-0-240 v. 15 amps., 5 v. 12.5 amps. 5 v. 1.75 amps. Ideal for ISOLATING TRANSFORMER, to obtain TWO 240 v. 360 watt lines Potted, oil-filled, 7 × 7½ × 10½in. high. Wt. 50lb **BRAND NEW.** £3/10/- Carr 10/-.

MAINS ISOLATING TRANSFORMERS (Vortexion) Fully shrouded. For testing A.C./D.C. sets in safety. 230 v. input. Output 230 v. 100 watts. 22/6. Post 2/6.
JACK BOXES. A small metal box fitted with 9 miniature insulated Igranic jack sockets. **BRAND NEW. SNIP.** 12/6.

XUM

SIGNAL GENERATOR



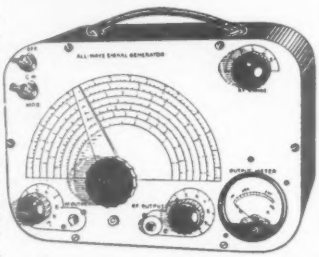
Coverage 100 Kc/s.-100 Mc/s. on fundamentals and 100 Mc/s to 200 Mc/s, on harmonics. Metal case 10in. × 6½in. × 5½in., grey hammer finish. Incorporating three miniature valves and Metal Rectifier. A.C Mains 200/250 v. Internal Modulation of 400 c.p.s. to a depth of 30%; Modulated or unmodulated R.F., output continuously variable 100 millivolts, C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%.

£6/19/6 Or 25/- deposit and 6 monthly payments of **21/6**. Post & Packing 5/- extra.

£4/19/6

Or **25**/- deposit and 4 monthly payments **21/6**. P. & P. 5/- extra.

SIGNAL GENERATOR



Coverage 120 Kc/s.-230 Kc/s., 300 Kc/s.-900 Kc/s., 900 Kc/s.-2.75 Mc/s., 2.75 Mc/s.-8.5 Mc/s., 8 Mc/s.-28 Mc/s., 16 Mc/s.-56 Mc/s., 24 Mc/s.-84 Mc/s. Metal case 10in. × 6½in. × 4½in. Size of scale, 6½in. × 3½in. 2 valves and rectifier A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent., modulated or unmodulated R.F., output continuously variable 100 milli-volts, C.W. and mod-switch variable A.F. output and moving coil output meter. Grey hammer finish case and white panel. Accuracy plus or minus 2%.

SIGNAL & PATTERN GENERATOR

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P. & P. 5/-.

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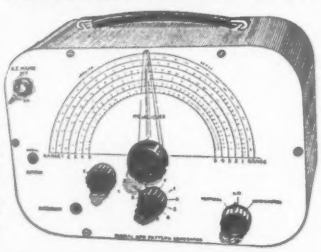

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COMPLETELY BUILT **PORTABLE AMPLIFIER**

Approx. size 6½ × 2½ incorporating 2 valves, contact-cooled metal rectifier, bass and treble lift controls and double wound mains transformer 230-250 v. ..... **39/6** Plus P. & P. 3/6.

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if purchased with the above **18/6**. Plus P. & P. 1/6.

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Model 456. 10 records. A.C. mains 200/250 v. Turnover crystal head. BRAND NEW. Fully guaranteed (suitable for use with above amplifier). **25**/- deposit plus P. & P. 5/- and 7 monthly payments of **25**/-.

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AC/DC POCKET MULTI-METER KIT

Comprising 2in. moving coil meter, scale calibrated in A.C./D.C. volts, ohms, and milli-amps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milli-amps. 0-10, 0-100. Ohms range, 0-10,000. Front panel, range switch, wire-wound pot (for ohms zero setting), toggle switch, resistors and meter rectifier. Basic movement 2mA. In grey hammer-finish case.

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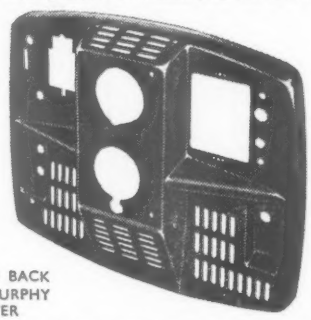

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A HIGH FIDELITY 30 WATT AMPLIFIER INCORPORATING PRE-AMPLIFIER AND TONE CONTROLS

EMPLOYING THE LATEST MULLARD EL34 OUTPUT VALVES IN ULTRA LINEAR OPERATION AND HIGH GRADE SECTIONALIZED OUTPUT TRANSFORMER.

Size approx. 13 x 8½ x 7in. Stoved gold hammered finish Weight 14lb. For operation on 200-250 v. 50 c.p.s. A.C. mains. Or other voltages to order. A chrome-handled cover is available at 19/6.

15 Retail Price GNS.

The Following Outstanding Test Figures Include Pre-amplifier and Tone Control Stages

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(Exc. Rumble Filter.) ±1 d.b. 20-20,000 c.p.s.

RUMBLE FILTER.
12 d b. per octave below 50 c.p.s.

BASS CONTROL.
Continuously variable +12 d.b. to −12 d.b. at 50 c.p.s.

TREBLE CONTROL.
Continuously variable. +12 d.b. to −6 d.b. at 12,000 c.p.s.

HUM LEVEL.
Referred to full output −73 d.b.

MAXIMUM POWER OUTPUT.
In excess of 33 watts.

MAINS POWER CONSUMPTION.
110 watts.

STABILITY.
Entirely stable with capacity of .08 mfd. in parallel with loudspeaker load.

EFFECTIVE OUTPUT IMPEDANCE.
0.9 ohms across 15 ohm terminals.

INPUT IMPEDANCE.
Both inputs 500k plus 10 pfd.

NEGATIVE FEEDBACK.
Total 28 d.b.

SENSITIVITY.
Input (1) 20 millivolts for rated output.
Input (2) 200 millivolts for rated output.

HARMONIC DISTORTION.
0.05% at 10 watts. 0.1% at 20 watts.

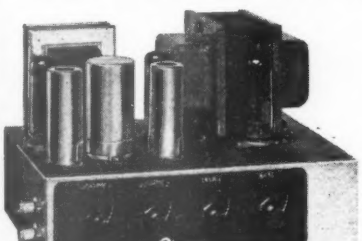
OUTPUT SOCKETS.
Provide matchings for 3 ohm and 15 ohm loudspeakers.

EXTERNAL POWER SUPPLY.
300 v. 30 m/a. 6.3 v. 1.5 a. for radio tuner.

VALVES.
B.V.A. EF86, EF86, ECC83, EL34, EL34, GZ34.
Due to use of Mullard EF86 valves microphony is virtually nil.
As in our extremely successful 'Diatonic' two individually controlled inputs provide mixing facilities for microphone and gram., etc., etc.

The 'DIATONIC' HIGH FIDELITY 10-14 WATT ULTRA-LINEAR AMPLIFIER

WITH INTEGRAL PRE-AMP AND TONE CONTROLS



Size only 9-7-6½in. Weight 12½lb. Power consumption 120 watts. Outputs for 3 and 15 ohm loudspeaker.

12 Retail Price GNS. For A.C. mains 200-250 v. 50 c.p.s. Or other voltages to order. Chassis finish stoved hammered gold, or grey blue.

Attractive cover with chromium carrying handles now available at 17/6.

Full advantage has been taken of the latest component miniaturization developments to reduce unit size to a minimum.

Two high impedance input sockets are provided for microphone and gram., etc. Each input has its associated vol. control.

B.V.A. valves are employed, ECC83, ECC83, EL84, EL84, EZ81.

ALL TEST FIGURES INCLUDE PRE-AMP FREQUENCY RESPONSE.
±2 d.b. 30-20,000 c.p.s

MAXIMUM POWER OUTPUT.
In excess of 14 watts.

RATED OUTPUT 10 WATTS.

SENSITIVITY.
Vol. (1) 22 millivolts for rated output.
Vol (2) 220 millivolts for rated output.

TREBLE LIFT CONTROL.
Continuously variable +6 d.b. to −13 d.b. at 12,000 c.p.s.

BASS CONTROL.
Continuously variable +13 d.b. to −18 d.b. at 50 c.p.s.

HARMONIC DISTORTION.
0.19% measured at 6 watts

HUM LEVEL.
Referred to maximum output −60 d.b.

NEGATIVE FEEDBACK.
Total 32 d.b.

H.T. and L.T. Supply Point is included for a radio tuner.

ALSO AVAILABLE:

The L45. A compact High Quality 4-5 watt amplifier.

Size approx. 6-5-5¾in. high. Sensitivity is 28 millivolts so that the input socket can be used for either microphone or gram., tape, radio tuner, etc. B.V.A. valves used are ECC83, EL84, EZ90. Controls are: Vol., Treble and Bass with mains switch. The Tone controls provide full compensation for long playing records. Output matching for 3 ohm oudspeaker.

Retail price **£5/19/6.**

THE LT45 TAPE DECK AMPLIFIER. A complete unit (power pack and oscillator incorporated) ready for connection to A.C. mains. 3 ohm loudspeaker and practically any make of deck. Negative feedback equalization adjustment by multi-position switch for 3¾, 7½ and 15in. per sec.

Retail price **12 gns.**

THE LG3 GRAM AMPLIFIER. Overall size 6¼ x 4½ x 2¾in. Controls: Vol. and Tone (with mains switch). Output for 2-3 ohm loudspeaker. All above for 200-250 v. 50 c.p.s. A.C mains

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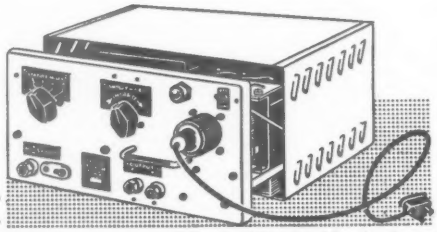

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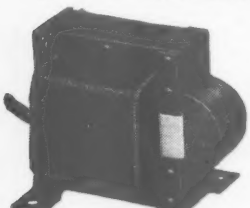

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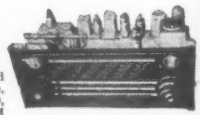

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6 valve, A.C. only, 3 wave-band, medium, long and FM. Built-in Ferrite Rod aerial. Geared gang drive, valves employed E.C.C.85, E.C.H.81, E.F.89, E.A.B.C.80, E.L.84, E.Z.80. Permeability tuned FM Section. Drift less than 30 KC from cold to complete warm-up. Chassis dimensions 15in. × 7½in., dial 15in. × 6in. Net Trade Price £19/8/6.

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This excellent unit is as new and is contained in polished bakelite case with carrying handle. The circuit uses 6 valves and operates from 2 v. l.t. and 120 v. h.t.

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THE NEW GELOSO V.F.O. UNIT. Output on 80/10 metres Complete with calibrated dial, £7/12/6, Set of three tubes, 24/-.
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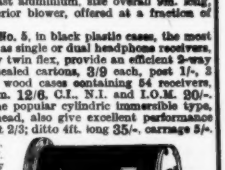

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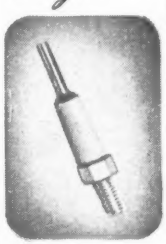

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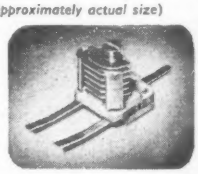

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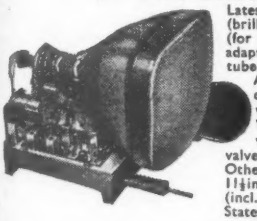

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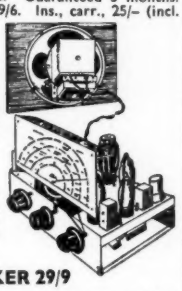

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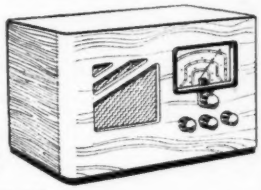

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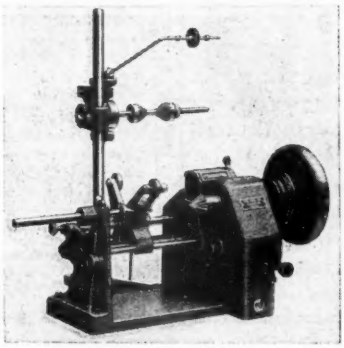

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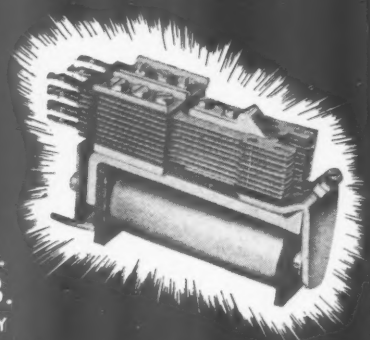

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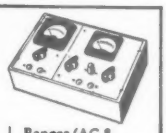

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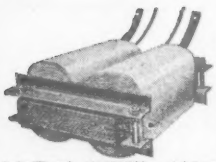

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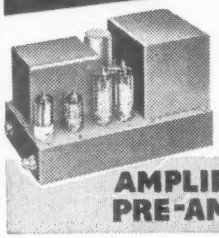

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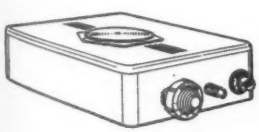

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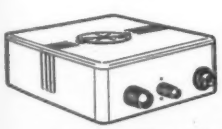

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A number of appointments are available for interesting work providing and maintaining aeronautical telecommunications and electronic navigational aids at aerodromes and radio stations in various parts of the United Kingdom.

Applications are invited from men aged 19 or over who have a fundamental knowledge of radio or radar with some practical experience. Training courses are provided to give familiarity with the types of equipment used.

Salary £600 at age 25 rising to £705. The rates are somewhat lower in the Provinces and for those below age 25. Prospects of permanent pensionable posts.

Opportunities for promotion to Telecommunications Technical Officer are good for those who obtain the O.N.C. in Electrical Engineering or certain City and Guilds Certificates. The maximum salaries of Telecommunications Technical Officers are Grade III £870, Grade II £1,030, Grade I £1,250.

Apply to the Ministry of Transport and Civil Aviation (ESB1/RT), Berkeley Square House, London, W.1, or any Employment Exchange (quoting Order No. Westminster 2109).

R.G.D.

The Radio Gramophone Development Co. seeks Senior and Junior Engineering Staff for work on Television Development.
Applicants should have experience in the following fields:—

Television Receiver Circuit Development.
Radio and Television Mechanical Development.
Colour Television.
Television Components.

These posts are permanent and progressive and occur due to expansion of an established and successful team.
Apply in writing, stating age and salary required to:—
Technical Director, R.G.D. Co., Ltd., Eastern Avenue West, Romford, Essex.

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THE INDEPENDENT TELEVISION AUTHORITY invites applications for the appointment of **SHIFT ENGINEERS**—salary scale £655 to £905.

A good knowledge of high frequency and television engineering practice is required. Preference will be given to applicants with some practical experience in the working of a television transmitting station. Successful applicants may be required to serve on any of the Authority's transmitting stations in the United Kingdom.

A contributory pension scheme is in force.

Applications, stating age, experience and qualifications, should be addressed to the **Personnel Officer, 14 Princes Gate, London, S.W.7.**

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Physicists or electrical engineers are required for research and development work with an organisation in outer N.E. London area manufacturing industrial and marine instruments.

Commencing salary range: £1,000-£1,400.

Qualifications: preferably an honours degree. Some years experience of research and development in electronics and telecommunications.

Experience in ultrasonics or light mechanical engineering would also be an advantage.

A contributory pension scheme is available, and assistance in housing or removal expenses may be given in suitable cases.

Applications, which may be made in strictest confidence, should give full details of qualifications, previous experience, age and salary required, and be addressed to Box 3996 c/o *Wireless World.*

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ELECTRONICS DEPARTMENT

Graduate Engineers or Physicists with two or more years experience in the field of microwave techniques or microwave receiver systems are required for theoretical or practical work in the development laboratories of the Radar Division. Applicants are requested to write, quoting reference F.10 to:—

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Please write to the **Personnel Manager** (ref: 616) at:—
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These appointments would be suitable for ex service personnel with operating or maintenance experience of wireless or radar equipment.

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Apply, giving full details and quoting reference WW.2036A to Mr. J. L. Scott, Department C.P.S., Marconi House, 336/7, Strand, London, W.C.2.

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Candidates with engineering or physics degree, H.N.C., or equivalent qualifications should apply in writing to the Personnel Superintendent, Siemens Edison Swan Limited, Brimsdown, Enfield, Middlesex. Applications will be treated as confidential.

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Applications please to the Managing Director, Felgate Radio Ltd., Felgate House, Studland Street, Hammersmith, W.6.

29

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The Senior Scientific Officer should possess Honours Degree in Physics or Engineering, or equivalent qualifications, and have at least three years' experience of working on Radio or Electronic Equipment.

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RESEARCH LABORATORIES.

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North Wembley, Middlesex. *Quoting reference RLL/WW/11A*

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Applicants should have had a sound Electrical/Electronic Engineering training, and should be familiar with modern electronic control equipment, including servo systems, control equipment for electrical machines, machine tool control, resistance welding controls, photo-electric equipment, etc., etc. This is a senior staff position with an expanding organization for a man with initiative and a keen interest in the automatic control field. The salary will be commensurate with qualifications, experience and ability.
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A Senior Engineer is required at the Feltham laboratories of the Company to direct a unit engaged on the development of I.R./electronic devices. A period of some 5-10 years' experience in I.R. work and evidence of administrative ability are required. Candidates should also have an honours degree or Ph.D. Please apply with full details to the **Personnel Department, E.M.I. Electronics Ltd., Engineering Development Division, Hayes, Middx.** Quote Reference Number EL/B.9.

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An Engineer with some experience is required at the Feltham laboratories of the Company to work on the sub-unit engineering and circuit design of the video pulse side of a radar system. Candidates should have an Engineering or Physics degree. Please apply with full details to the **Personnel Department, E.M.I. Electronics Ltd., Engineering Development Division, Hayes, Middx.** Please quote reference number EL/B.20.

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Development and Maintenance Engineers
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Assistant Engineers
Wiremen

Applicants should have experience in design, construction or maintenance of television equipment.

Write giving full details of age, experience, salary, etc., to :—

Senior Engineer, Installations and Planning,
ASSOCIATED TELEVISION LIMITED
Television House, Kingsway, London, W.C.2

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A Senior Engineer is required at our Feltham laboratories to supervise and extend the work of a Systems Study Group attached to a G.W. Project. This entails investigation of new developments and extension of existing systems to new applications. A good degree in engineering or physics together with a wide experience of electronics and preferably including a knowledge of microwave, servo-mechanisms or pulse theory is essential. Please write with full details to

Personnel Department (EL/B.40),
E.M.I. Electronics Ltd.,
Engineering Development Division,
Hayes, Middx.

SENIOR ENGINEER

required to take charge of post design services section dealing with a range of U.H.F. communication equipments now entering service. Applicants should possess qualifications equivalent to H.N.C. or City and Guilds Final Examination. Experience in liaison with ministry and service departments desirable. Ex service technical signals officers considered. Salary £1,000 to £1,360 per annum according to circumstances.

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to work on the design of miniature transistorised electro-acoustic devices.

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required for interesting new communications development projects. Applicants should possess H.N.C., City and Guilds Final or equivalent qualifications. Previous communication experience desirable but not essential. Knowledge of services and K.114 requirements would be an advantage. Salary according to experience up to £1,000 per annum. London Area. Good staff working conditions. Please reply, giving full details and quoting Ref. No. 6382, to the **Employment Manager, The Plessey Company Limited, Vicarage Lane, Ilford, Essex.**

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Television Test Gear Laboratory

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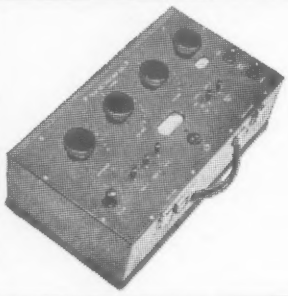

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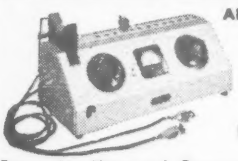
PRICE £25



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PRICE £5/10/-. Packing and carriage 15/-.

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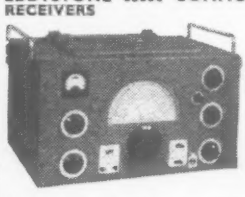

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2½in. Rd. Flush M.I. A.C. Voltmeter with internal matched resistance, range 0 to 300V A.C.	£1 2 6
2½in. Rd. Flush M.C. Centre Zero, 100-0-100 μA FSD, calibrated 0 to 200mW	£1 5 0
3½in. Rd. Flu.h M.C. Centre Zero, 0.5-0-0.5mA FSD, calibrated 50-0-50, resistance appr. 40 ohms.	£2 0 0
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Double Press Key with changeover contacts and hold-down knob.
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2.5 kVA WELDING TRANSFORMERS for 230 v. mains. Two output sockets 25 amp. and 50 amp. at 50 v. Output voltage adjustable by means of "off-load" tappings. Permissible momentary overload up to 100%. Waterproof input and output sockets.
PRICE, brand new £15 0 0
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ATTENUATORS STC decade type, model 74101, range 75db, impedance 600 ohms..... £12 0 0
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Record "Minor" 500V Insulation Tester, complete with leather case	£10 0 0
Evershed Series 1 Megger Insulation Tester, 500 Volts, 40 megohms	£25 0 0
Evershed Series 1 Megger Insulation Tester, 1,000 Volts, 100 megohms, from	£27 10 0
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HALLICRAFTERS S-27C, range 130 to 210mc/s FM/AM reception: Power Supplies 115 V. A.C.
R-1294 RECEIVERS, Frequency Range 500 to 3,000mc/s. *Prices and details on application.*

SIMPLE TWO-DECADE WHEATSTONE BRIDGES

0 to 200 ohms in one-ohm steps (no ratio arms); built-in galvanometer 2.5-0-2.5 mA.
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SCANNERS RC-94D for SCR-720 Radar Equipment, modified for use with Meteor Aircraft, complete or components.
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615 (metal)	4/6	0D3/VR150	4/-
6N7	7/-	VR105/30	5/6
6SJ7	7/6	C.R. Tube 5CP*	50/-

POSTAGE 6d. PER VALVE

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Klystrons 417A
Magnetrons 5J29; 5J30; QK59; QK61; QK62.

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WARNING

Readers are warned that Government surplus components and valves which may be offered for sale through our displayed or classified columns carry no manufacturers' guarantee: Many of these items will have been designed for special purposes making them unsuitable for civilian use, or may have deteriorated as a result of the conditions under which they have been stored. We cannot undertake to deal with any complaints regarding any such items purchased.

NEW RECEIVERS AND AMPLIFIERS

SHIRLEY LABORATORIES, Ltd., 3, Prospect Place, Worthing, Sussex Tel. 30536.

THE TWA/1515 stereosonic tape recording and replay amplifier, separate meter monitoring on record and playback on both channels, 15watts O/P each channel, 96gns, TWA/15 tape recording and reproducing amplifier, 15watts O/P, for Wearite and Collaro decks, 45gns; TW/PA recording and replay pre-amplifier, 30gns; both with valve voltmeter monitoring; type SB/1-15E high-fidelity amplifier exceptionally wide tone-control system, 40mv sensitivity, 20gns; with two inputs and 3-position gram filter, 22gns; specialized amplifiers for the musical and scientific industries including the Mullard 20watt. [0095

RECO transistor kits are best.—See Radio Exchange advertisement on page 179 or send 2/- for data, circuits and price list to Radio Exchange Co., 27, Harpur St., Bedford. [7669

HI-FI at low cost; our AM/FM R/G chassis and feeders are grand performers at highly competitive prices; we particularly emphasize our Model A/F834, and 8 valve 3 waveband 4 watt chassis with gram switching, also Model A/73 AM/FM feeder, trade enquiries invited.—Bayly Bros., 46, Pavilion Drive, Leigh-on-Sea, Essex. [7551

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HI-FI leak TL/10 amplifier and pre-amplifier, as new, unused present, cost £28/7; £23.—Box 3834. [7668

HRO Rx's and coils in stock, also AR88, BC348R, CR100, etc.—Requirements please to R. A. or L. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0055

EX R.A.F. G.E.C. airfield amplifier equipment incorporating five 175W individual amplifiers complete with valves, and offered on a fully power packs; distribution and test panels; complete with valves, and offered on a fully tested basis; £150 ex-works.
GEORGE COHEN SONS & CO., LTD., Wood Lane, London, W.12. Tel.: Shepherds Bush 2070 and Stanningley, Nr. Leeds. Tel. Pudsey 2241. [7566

TEST EQUIPMENT—SURPLUS AND SECONDHAND

AVO electronic testmeter, as new, BC211, good condition.—Box 4137. [7703

SIGNAL generators, oscilloscopes, output meters, valve vo.tmeters, frequency meters, multi-range meters in stock; your enquiries are invited.—Requirements to R. T. & B. Service, 254, Grove Green Rd., London, E.11. Ley. 4986.

TEST EQUIPMENT WANTED

WANTED, Weston Eng. or U.S.A. E772, faulty complete meter or movement.—Box 4126. [7701

NEW COMPONENTS

CRYSTAL microphone inserts (Cosmocord mic 6/4); guaranteed newly made and boxed; 15/6 post free.—Radio-Aids, Ltd., 29, Market St., Watford, Herts. [0170

COMPONENTS—SURPLUS AND SECONDHAND

AMAZING offer by Waltons of Wolverhampton.
12 DIFFERENT relays of U.S.A. and English manufacture for 37/6 and 2/6 post and packing; large purchase enables us to make this unique offer! Each parcel of 12 includes some or all of the following types: Post Office, miniature, super sensitive, high speed, light and heavy duty, etc., etc.; we cannot select individual types nor repeat once existing stocks are cleared; send now!
WALTONS WIRELESS STORES, 46-48, Stafford St., Wolverhampton: [0147

SOUTHERN RADIO SUPPLY, Ltd., 11, Little Newport St., London, W.C.2. See our displayed advertisement page 186.

A LIST is ready that will make your eyes pop; send your billhead, we only supply the trade and export.—A.W.F., Dept. WW, 10, Sackville St., Bradford, 1. [0151

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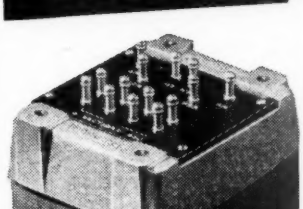

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COLLARO 3-speed Ortho auto unit, Leak TL12 with pre-amp and Chapman v.h.f. unit, Axiom 150 speaker, will separate.—Offers to Poste, 112, The Avenue, E.4. [7695

MAGSLIPS at low prices, fully guaranteed, No. 3 in Resolver No. 5 (AP 10661), 50v. 50c/s, unused each in tin, 35/-, post 2/1; large stocks of these and other types.—P. B. Crawshay, 94, Pixmore Way, Letchworth, Herts. Tel. 1851. [0087

ILLUSTRATED Catalogue No. 13 containing over 450 items of Government surplus and model radio control equipment, 2/2, refunded on purchase of goods, 2/6 overseas sea mail.—Arthur Sallis Radio Control, Ltd., Department W.W., 93, North Rd., Brighton. [0193

T.V. tubes £1, including carriage!!! This ridiculous price owing to slight screen burns, but giving perfect picture!! Ideal for stand-by or for testing; 14in and 17in rectangular.—Duke & Co., 621-3, Romford Rd., Manor Park, E.12. Tel. Ilf. 6001-3. [7608

CATHODE ray tubes used but in good working order with three months' written guarantee, 12in to 17in Mazda, Mullard and equivalent types only at £4/10 each plus 12/6 for carriage and insurance; enquiries and orders to BHP Distributors (London), Ltd., 379, Staines Rd., Hounslow, Middx. Tel. Hou. 5144. Our terms are C.W.O. or C.O.D. [7684

NEW GRAMOPHONE AND SOUND EQUIPMENT

DON'T miss the LP tape sale of Sound News. —See under tape recording etc. [0194

GLASGOW.—Recorders bought, sold, exchanged, cameras, etc., exchanged for recorders or vice versa.—Victor Morris, 406, Argyle St., Glasgow, C.2. [0201

CINE-VOX disc recording mechanisms for L.P. or standard operation from 30gns.-56gns.; also complete tape disc or direct channels from 50gns.-112gns.
DEMONSTRATIONS can be arranged in London.—For full details write to K.T.S., Ltd., "Coplow," Park Rd., Braunton, N. Devon. Callers by appointment only. [0210

TAPE Recorders, Ferrograph, 76gns; Reflectograph, £87; Brenell, 48gns; tape decks Wearite, Collaro, Truvox; microphones, Reslo, S.T.C., Acos; amplifiers, Leak, 27gns; Quad, £42; hire purchase facilities available; high fidelity tape to disc service.—Lambda Record Co., 4, Kimberley Ave., Liverpool, 23. [6884

ALL makes of tape recorders in stock. Ask us about our new high quality, low cost 'Addatape," can be connected to amplifier making a real Hi-Fi recorder or plugs into radio; leaflets and prices on request; our terms can't be beaten! Special offer—1,200ft plastic recording tape, only 22/6, plus P. & P. 1/6.—E. C Kingsley & Co. (F), 132, Tottenham Court Rd., London, W.1. Euston 6500. [7560

TAPE recorders for home and industry; Brenell, 53gns; Ferrograph recorders from 79gns; Leevers-Rich from £450 according to specification; Standard and L.P. tapes; high quality mics, "Cadenza" & Reslo, etc.; speakers, tuners, etc.; tape/disc and complete recording service.—"Eroica" Sound Recording Services (1949), 31, Peel St., Eccles, Manchester Eccles 1624. Director: Thurlow Smith, A.R.M.C.M. [0122

GRAMOPHONE AND SOUND EQUIPMENT—SURPLUS AND SECONDHAND

C.J.R. D5 tape recorder, 9¾ spools, £75 or offer; W.W. 1950-7.—Box 3774. [7663

VORTEXION 2B tape recorder, purchased October last, perfect; £100 o.n.o.—Box 4011. [7686

ADMIRALTY type Robot 78 disc cutter, needing slight attention; (inspection W. Ewell); £28.—Box No. 4120. [0232

LEEVERS-RICH recorder, cost £450 August, 1957, offers; S.T. & C. Carlod 4033 microphones, cost £50, sell £40, mint; 16in transcription turntable, £10; Celsonic tape recorder, cost £100 1957, sell £65 with 5,000ft tape spools.—Marsh, Little Place, Moss Delph Lane, Aughton, Ormskirk, Lancs. [7700

CLEARANCE lines, new Collaro Mk. III tape deck, wired complete with preamplifier and power amplifier, mike, loudspeaker, ready to fix in cabinet, £50; a few only, handsome 4-speed record players, in beautiful two-tone rexine carrying case, £16 16; a few only 4-speed record players in beautiful polished wooden case cases may be slightly marked, £16 16; AM FM radio chassis, magic eye tuning with illuminated scale, loudspeaker and knobs, £22 16; midget record players in handsome red rexined case with carrying handle, using B.S.R. TU9, 4-speed changer, £10 10; record player amplifiers 2½-3 watt, knobs and loudspeaker, £4 15; all items carriage paid; send now.—Basildon Radio Co., Ltd., 73, Cricketers Lane, Herongate, Essex. Tel. 214. [7675

TAPE RECORDING, ETC.

TAPE to disc, Queensway Recording Studios, 123, Queensway, W.2. Bay 4992 Recorders serviced and for hire [7421

HAVE your tape recordings transferred to discs; quick service.—Supertone Radio, 29, King St., W.3. Acorn 2594. [0196

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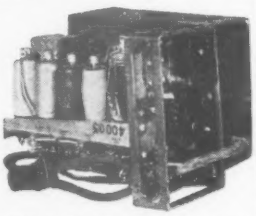

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OFFER No. 2:
Transmitter-Receiver "38," as above, complete with set of external attachments, 42/6, post paid.

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USE Britain's oldest full-time tape/disc transfer service for LPs and Mark 78s (still 1952 rates).—Sound News Productions. 59 Bryanston St., London. W.1. Amb. 0091. [0192

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WANTED, EXCHANGE, ETC.

AUTOMATIC voltage regulators W.1698, Admiralty pattern required.—Box 3616. [7647

WANTED, scrap aircraft plugs; cash by return.—La-Posta, Watchmaker, Camborne, Cornwall. [7651

NEW or second-hand model 3A NH Ferrograph tape recorder.—Gillett, "Cedars," Middleton-on-Sea, Sussex. [7689

VALVES (new), tape recorders, test equipment, any quantity.—Stan Willetts, 43, Spon Lane, West Bromwich, Staffs. Tel. Wes. 2392. [7079

WANTED, HRO coils, Rxs., etc., A.R.88s, BS348s, S27s, etc.—Details to R. T. & I. Service, 254, Grove Green Rd., London, E.11. Ley. 4986. [0163

URGENTLY required, scrap platinum wire, contacts, etc.; spot cash for any quantity; £24 per oz troy.—The Scientific Metal Co., 50, Old Brompton Rd., London, S.W.7. [7667

WANTED for cash!—Tape recorders, tape, Hi Fi equipment, etc.; best prices from E. C. Kingsley & Co. (F), 132, Tottenham Court Rd., London, W.1. Euston 6500. [7523

WANTED, transmitter T.59, transreceivers TR.1520, 1934, 1935, 1936, 1937; receivers BC.312 and type 100, P.S.U. type 381; dynamotors DM.21 and DM28.
GILFILLAN, 7, High St., Worthing. Tel. 8719. [7679

A BETTER cash offer awaits you for your brand new surplus; valves, components, speakers and test instruments, etc.—R.H.S., Dept. W, 155, Swan Arcade, Bradford, 1. [0190

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WANTED, BC610 Hallicrafters, E.T.4336 transmitters, BC312 receivers, BC221 frequency meters and spare parts for all above; best cash prices.—P.C.A. Radio, Beavor Lane, Hammersmith, W.6. [0079

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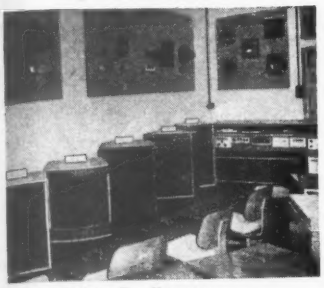

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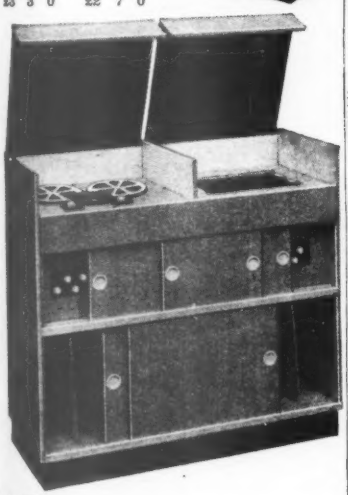

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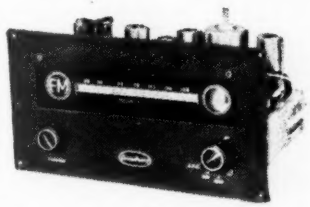

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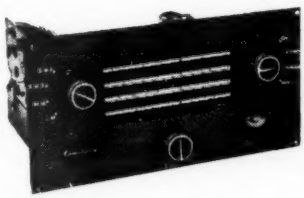

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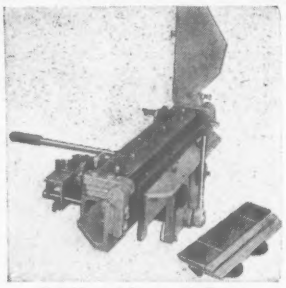

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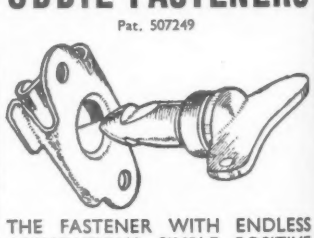

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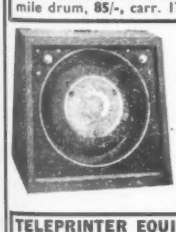

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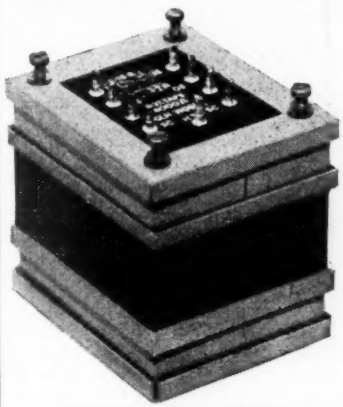

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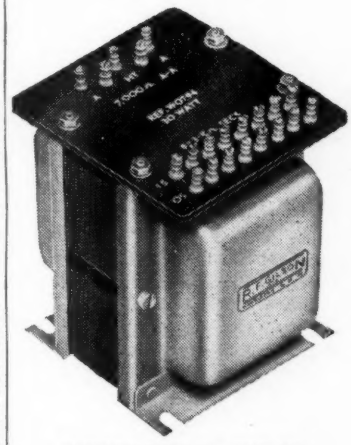

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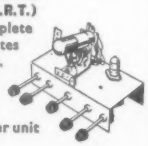

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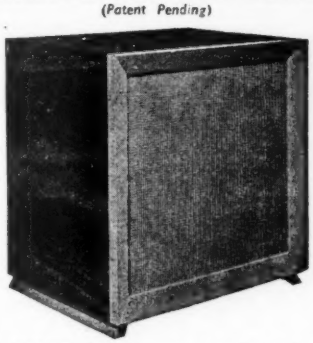

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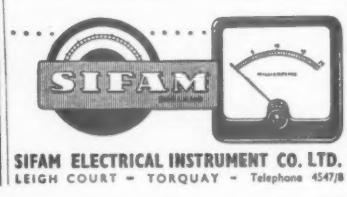

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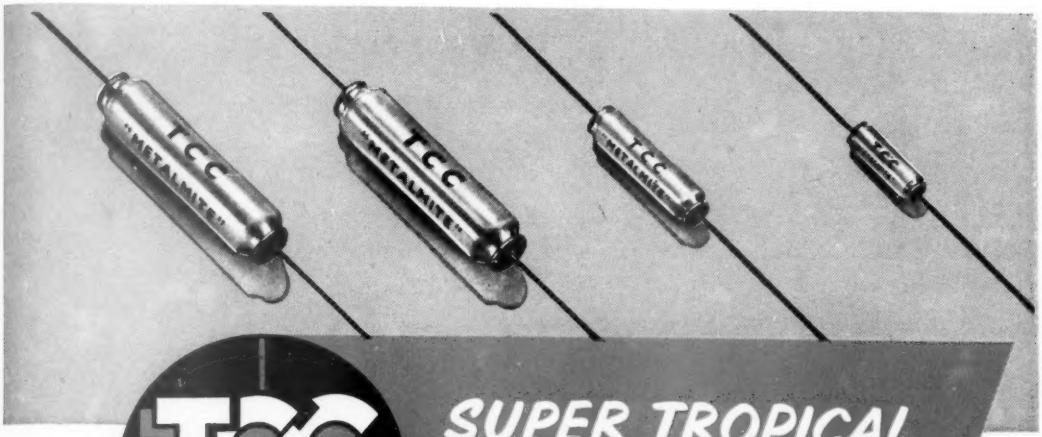

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